NATURE

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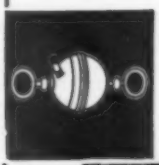

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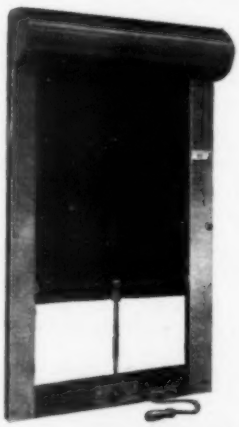

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Civil Aviation in Great Britain

THROUGHOUT the post-War period, the development of civil aviation in Great Britain as in other countries has been warped by military demands. The report on the Economics of Air Transport in Europe submitted by M. Henri Bouché to the Air Transport Co-operation Committee of the League of Nations in 1935 revealed not only the uneconomic position of civil aviation in Europe generally, but also the way in which national prejudices or military arguments have deprived civil aviation of the freedom which would enable it to reap the advantages inherent in its potentially greater speed as compared with surface transport. In observations on the recently issued report of the Committee of Inquiry into Civil Aviation, which was under the chairmanship of Lord Cadman, the Government has admitted that the unprecedented effort of the Air Ministry and the aircraft industry of the last two years in the military sphere have accentuated the neglect of civil attention, although it is now thought to be possible to give further assistance to civil aviation and to improve its organization.

The present report (Cmd. 5685. London : H.M. Stationery Office, 1938. 1*s.* 6*d.* net) is the outcome of a storm of Parliamentary criticism of British civil aviation in November last, which indeed led to the reconstruction of the membership of the original committee, and the contents of the report confirm the soundness and pertinence of much of that Parliamentary criticism. No one who reads the report or who followed the subsequent debate in the House of Commons can be in doubt as to the room or need for further and strenuous efforts in the field of civil aviation and world air transport, and the report should stimulate both interest and constructive criticism in this field. The need for the continuous pressure of informed opinion is sufficiently illustrated by the reference in the report to the failure to give full effect to the recommendations of the Maybury Committee on the development of civil aviation in the United Kingdom, although their acceptance by the Government was announced more than a year ago.

It should not, of course, be overlooked that the Government policy of concentrating on the development of Empire routes, which constitute 90 per cent of the total mileage operated by Imperial Airways Ltd., has to a large extent been fully justified, and that such services have advanced much further towards financial autonomy than the great majority of Continental routes, which, as was shown by M. Henri Bouché and is pointed out again in this report, are much more heavily subsidized. So, too, the report finds no evidence that Imperial Airways' services are less safe than those of any foreign company or that traffic considerations are allowed to outweigh prudence.

The report emphasizes the necessity of closely associating and co-ordinating four elements in civil air transport if successful development is to be assured. There is first the machinery of Government, covering such matters as the initiation of policy, consideration of the international implications of civil aviation, stimulating the development of aircraft, and controls required in the interests of safety. Then there is the aircraft operator, who will give practical effect to Government policy by developing air transport with energy and foresight. Thirdly, there is the aircraft constructor, and lastly the provision of essential ground organization.

The Committee recognizes that the military aspect of aviation cannot fundamentally be separated from the civil aspect, and emphasizes

the necessity for much more virility in the initiation of policy and foresight in planning. The stimulation of research and design and the production of civil aircraft, as well as the encouragement of suitable organization of the aircraft industry, devolve upon the Secretary of State. Continuity in directing the policy of aircraft research, development and production is essential, and the Committee trenchantly criticizes the present system of expecting a military officer without previous knowledge and experience of such matters and holding office for a limited term to deal effectively with the situation.

The recommendation for the creation of a post of Permanent Under-Secretary of State for Air to assume control of this Department has already been accepted by the Government, as have further recommendations for the appointment of a Deputy Director of Civil Aviation and a Director of Civil Research and Production, and for strengthening the technical staff concerned with research and development. The Government, however, has not accepted the recommendation of the Committee that the functions of the Member for Research and Development on the Air Council, and also that part of the Department administered by the Air Member for Supply and Organization which deals with the production of aircraft, should be transferred to the Permanent Under-Secretary of State, as it is considered that such changes would seriously interrupt the work of the Service side of the Air Ministry.

In its observations on this question, the Government points out that the Department of Research and Development is already an extensive organization, largely civilian and permanent, the Director of Scientific Research being a permanent officer and a scientific worker of high repute. The Department is in close touch with other Government research establishments, with universities and with private firms, and its research and experimental establishments provide testing stations and a central laboratory for theoretical research. The Government contention that research and development on the Service side are in fact continuous and progressive, and that much of this work is of immediate value and available to makers of civil aircraft, is, however, not disputed by the Committee. Its contention is that, in the past, most of the research undertaken by the Air Ministry has had a military bias, and the reorganization recommended is intended to ensure that civil research work is given due prominence in future.

The tenor of the Government observations on the subject of research is accordingly less reassuring than might be desired, and the Prime Minister's silence on the subject in the debate is in itself disturbing. It is suggested, in fact, that instead of defence requirements drawing on the general body of scientific knowledge and applying it to the particular problems of defence, supplementing it by further investigation as required, in the field of aviation this policy is to be reversed and the trend of development dictated by Service requirements. This very policy has restricted and warped the whole development of civil aviation since the War, and it is optimistic to expect much improvement until the resources available for research and development in aviation are administered by those possessing not only the essential technical and administrative qualities, but are also trained to view the subject as a whole and not primarily in respect of Service requirements.

This is indeed the main point in the Committee's contention that the direction of aircraft research, development and production should be transferred from a military to a civil officer, not necessarily a technician, but possessing high ability, energy and proved capacity for organization. It is further supported by the reference to specific problems of research, such as the icing problem, with which two appendixes to the report deal in some detail. The prevention of ice formation is indeed a composite problem affecting the engines, airscrews, instruments, wireless equipment and the air frame itself, and the report insists that research into this problem should be prosecuted with the utmost vigour.

Other research problems to which the report directs special attention include such matters as pressure cabins, automatic blind landing equipment, anti-static electricity devices and the application of wireless to aviation purposes, in all of which evidence was submitted that Great Britain is not keeping pace with the United States of America, while special attention to lines of research which would make flying safer is also urged. It is indeed pointed out that unless a limit is soon put to the size of aerodromes, considerations of cost may prove a serious handicap to further progress, and on this ground alone a reduction in the landing speed of air liners without impairing performance in other respects is desirable.

Scientific workers can scarcely fail to be keenly interested in these technical problems as well as in the recommendations relating to policy and

reorganization intended to give civil aviation some of the freedom of development of which it has been deprived largely by defence considerations. They will, however, be equally interested in the comments of the report on staff questions. Here the report is perhaps unduly reticent, and its criticism is implied rather than openly expressed. That it should be necessary for a report of this type to make the recommendation that personal contact between employer and employee in air transport should be supplemented by collective representation is a serious reflection on the management concerned, and its significance cannot be appreciated without regard to the great advance in dealing with staff matters characterizing large-scale progressive industry in recent years. The fact that the Committee should find it necessary to recommend that dividends should be restricted to the limits usually associated with public utility companies—a principle with which the Prime Minister announced his sympathy—further indicates how far the managements of Imperial Airways or British Airways Ltd. has lagged behind the best practice and principles of modern management.

There can be no two opinions that the inquiry instituted has been thoroughly justified, and if the recommendations of the report are implemented there is reason to believe that civil aviation in Great Britain may be liberated from some of its shackles. None the less, it is clear from the Government observations that defence considerations remain the dominant factor, and it should not be forgotten that civil aviation can only gain its true freedom in the international sphere. Fundamentally, moreover, the report is a telling indictment of the management of the industry, and adds yet one more warning to others in the past of the dangers to the community of allowing control to remain in the hands of those who are incompetent to take long-range and progressive views, or to assess accurately and sympathetically the technical and human as well as the financial issues involved. In these days, when the resources at the disposal of scientific management are so vast and accessible, there is less excuse than ever for maladministration, and failure to ensure that those in control possess the administrative capacity for their task is more likely than any other factor to involve the downfall of social or industrial institutions to-day.

Petroleum Technology

The Science of Petroleum: a Comprehensive Treatise of the Principles and Practice of the Production, Refining, Transport and Distribution of Mineral Oil. Editors: Dr. A. E. Dunstan, Prof. A. W. Nash, Dr. Benjamin T. Brooks, Sir Henry Tizard. Vol. 1. Pp. xxvi + 836. Vol. 2. Pp. xvi + 837–1670. Vol. 3. Pp. xvi + 1671–2386. Vol. 4. Pp. xvi + 2387–3192. (London: New York and Toronto: Oxford University Press, 1938.) 4 vols., £15 15*s*. 0*d*. net.

EVEN in an age of industrial achievement the economic efficiency of the petroleum industry is outstanding. In particular, its products have been progressively and rapidly adjusted to the ever-changing requirements of a world largely based for its mechanized civilization upon the internal combustion engine. What is still more striking is that many of these adjustments have been made in advance of the engine-builder's demand for them. The designer has been encouraged in effect to produce more and more efficient units because of the special fuels and lubricants waiting to his hand. He now sets no limits to his requirements in this direction, for he knows from experience that the oil industry will serve him to the fullest extent of its resources even if it means scrapping (as often happens) the highly successful plant and process of the previous day.

This spirit of deliberate self-modernization is evident throughout the oil world. It is significant that the biggest technical advances and productive successes in the search for petroleum by geophysical means have been made at a time when visible reserves of oil are greater than ever in the past and when production in many quarters has had to be artificially restrained. It is equally worthy of mark at the other end of the scale that chief encouragement of the synthetic production of oil has come from the large petroleum undertakings, and not from the coal or similar interests, which might be expected most directly to benefit.

The great research stations of the petroleum industry and its modern refineries; its geophysical surveying, high-pressure drilling and thousand-mile pipe lines; its tanker fleets, its distribution organization and its resolute development of a new synthetic chemistry, all reflect a standard of technical and administrative attainment which it

is difficult to parallel. There is, too, an atmosphere of audacity about some of its doings which compels recognition of the industry's aliveness and youthfulness. That is probably the answer to many things in the petroleum industry. It is young, it is successful. It has money, it has vision. Through these it has been able to attract to itself men of high capacity and to reward them. As a result the last two decades have seen within the industry's wide range of interests a complete departure from all empirical methods and a dependence upon organized development and control which can only be apprehended with difficulty even by those directly concerned with oil in one way or another.

It follows that the scientific basis of the exploitation of petroleum must be very wide. How wide can be partly judged by a statistical description of the work under review.

This work consists of four quarto volumes weighing approximately two stone and containing more than 3,000 pages. It has been produced by the co-operative efforts of four editors, twenty-four associate editors, 316 contributors and many secretaries, index-compilers and general assistants. It is divided into five parts and 44 sections. Each section contains a sufficient number of papers from specialist contributors to cover all aspects of a particular subject without loss of the individuality arising from separate authorship. The subjects range from nomenclature to shale oil. They cover the origin of petroleum, its distribution, exploration, winning and transportation; physical and chemical data and testing; refinery processing of all kinds; cracking, re-forming and hydrogenation; manufacturing materials, instrumentation and use of commodities; direct products and their utilization; synthetic derivatives and bitumen.

The intrepidity involved in undertaking this work can only be matched by the tenacity of purpose which has brought it to successful issue. Dr. Dunstan, Prof. Nash, Dr. Brooks and Sir Henry Tizard are severally to be congratulated on the completion of a task which they must at times have felt to be endless. To them and to the publishers are due the sincere thanks of all interested in the "principles and practice of the production and refining of mineral oil". They have done what they set out to do and have produced a "Comprehensive Treatise". The work is not merely a landmark in the history of the literature of petroleum—it is a record of knowledge and achievement which must inevitably form the basis of all future writings on similar lines, whether they be digest or dissertation. Moreover, by being collated in the form of groups of individual papers, its own supplementation should be fairly straightforward. It is obvious that arrangements for keeping the treatise up to date will have to be made right away.

The list of contributors discloses the fact that as to four fifths of the work they are drawn about equally from Great Britain and the United States. This is flattering to the British position in the oil world, and is accounted for by the preponderatingly British editorship. Although there are missing in consequence a number of well-known specialists whose participation might have been anticipated, critical perusal of certain articles they might have written fails to disclose that anything has been lost in calibre thereby.

Vol. 1 is concerned with geology and production—350 pages of the former and 500 of the latter. As with the remainder of the treatise, it is just not possible within the scope of a review to indicate the breadth of the special subjects covered. It is only by comparison with corresponding matter written years ago that the remarkable advances in procedure and ideas can be gauged. They are perhaps most spectacular in the case of the methods available for geological mapping, but are equally true as regards production. The repressuring of fields, the use of gas-lift, the control of oil-field water, and conservation methods generally are all directed towards the elimination of waste and general improvement in the utilization of resources. It is significant of modern dependence upon scientific method that some of the most mathematical articles in the whole compendium are to be found in just those sections which in the past would have been regarded as the exclusive domain of the practical driller.

Since the success of an industry must depend largely on the standard of its products, it is natural, however, that "The Science of Petroleum" should be concerned outstandingly with chemistry and chemical engineering. These aspects are copiously covered in vols. 3, 4 and 5, dealing with composition, testing, refining and utilization. The sections dealing with cracking, hydrogenation and re-forming are all well done, but are likely to be those which will need revising first. It is in this direction of the tearing apart of the hydrocarbon molecules of petroleum and their rebuilding into even more effective commercial combinations that most progress is being made. What was an almost wholly analytical industry is now largely synthetic in character, quite apart from its modern concern with the production of special chemicals.

Every man interested in oil will wish to possess these volumes. That should apply from driller to depot manager and include the worker with synthetic, as well as natural, petroleum. Incidentally, he will greatly admire their appearance on his shelves, and, whilst reading them, the truly wonderful technique of their production. S. J. M. AULD.

Mental Defect

A Clinical and Genetic Study of 1280 Cases of Mental Defect

By Dr. L. S. Penrose. Pp. 159 + xiv. (Medical Research Council. Special Report Series, No. 229). (London: H.M. Stationery Office, 1938) 2*s.* 6*d.* net.

THE eugenic movement has laid great stress on the burden imposed on the community by the existence in the population of about 1 per cent of mental defectives; and extravagant statements have been made both for and against the possibility of reducing the incidence of mental defect by eugenic measures. Thus it has been stated, on one hand, that mental defect could largely be eliminated by the sterilization of defectives, and, on the other, that it could largely be controlled by prenatal hygiene or improved obstetrics.

Dr. Penrose's report will not please the extremists of either school. It is an extraordinarily painstaking record of facts. No fewer than 1280 patients in an institution; and 56,198 of their relatives, were investigated. With such large material it is possible to classify defectives not only by the grade of mental defect, but also in 76 per cent of cases by their clinical type.

7·3 per cent were due to congenital syphilis or to cerebral trauma or inflammation. Perhaps another 3 per cent (including cases of hemiplegia and disseminated sclerosis) might be put down entirely to environmental effects. In the remainder, genetical causes play at least a considerable part in determining the abnormality.

4·9 per cent of cases were due to mongolism, where genetical and environmental factors interact. For while the condition was ten times as common amongst their relatives as amongst those of other patients, the mean age of their mothers was 38·2 years, as compared with 29·4 years for other patients. 1·0 per cent of cases were due to three well-recognized dominant genes causing epiloia, neurofibromatosis, and Huntington's chorea. There is a very strong case for preventing the breeding of persons afflicted with these diseases, whether mentally defective or not. As, however, new cases constantly occur by mutation, and Huntington's chorea may only show up late in life, this would not abolish the diseases in question, though it might reduce their incidence by more than half.

7–10 per cent of all cases were probably due to fairly clear-cut recessive genes. One of the most striking results of Dr. Penrose's investigation is to make it highly probable that congenital cerebral diplegia, which accounts for 5·1 per cent of all cases, is a recessive character. The segregation into normals and abnormals was unusually clear cut, and there was consanguinity in 9 per cent of cases. Other recessives include phenylketonuria, a metabolic abnormality which always causes mental defect; cerebromacular degeneration; retinitis pigmentosa; deaf mutism in some families; and probably cretinism. The frequency of consanguinity in other cases suggests the presence of recessive genes.

But the majority of cases were not so simply determined. There was a good deal of certifiable defect, and still more dullness, among the parents and other relatives. This was particularly so in the case of simpletons (feeble-minded). This is what we should expect if the milder grades of mental defect were determined mainly by the interaction of a number of partly dominant genes, and to a small extent by the environment.

What practical steps are suggested by the report? 7–9 per cent of the defectives had one parent sufficiently defective to be certified or certifiable. It follows that had all defectives of certifiable grade a generation ago been segregated or sterilized, 7–9 per cent of these patients would never have been born. This number must possibly be reduced for the whole population, as defective children of defectives are perhaps more likely to be institutionalized than defective children of normals.

Again, 3·5 per cent of all patients had consanguineous parents. Had first-cousin marriages and the illegal unions of closer relatives been prevented, 2·4 per cent of the defectives would not have been born. Finally, 4·7 per cent of the patients had thyroid disorder, of which an early treatment would in many cases have cleared up the disease; 3·9 per cent had congenital syphilis, which is preventable. Others were victims of birth injury, meningitis, and encephalitis, which are at least partially preventable. The cases of pituitary and other endocrine disorder are likely to be brought within the scope of therapeutics fairly soon, if they are not yet so. Since diabetes can be dealt with by insulin, a hormone controlling the oxidation of phenol-pyruvic acid may yet be found.

It would seem, then, that negative eugenics and therapeutics are about equally hopeful as preventive measures, whilst the prevention of inbreeding, though not negligible, is definitely less promising. But all three measures would not, in the present state of our knowledge, prevent 20 per cent of cases.

We need more knowledge, and this report certainly lays the foundations for future research. I have no doubt that it is the most important

contribution to human genetics which has been made for many years in any part of the world, and the Medical Research Council, the Darwin Trust, and the Royal Eastern Counties Institution, are to be unreservedly congratulated on it. The diagnosis and family history of every single case is given in an appendix which will be of the very utmost value. However, certain parts of the report require amplification, which they will doubtless receive elsewhere.

I trust that this report may be the beginning of a series which will be as valuable as those on nutrition and bacteriology, which are, of course, indispensable. J. B. S. HALDANE.

The Gorilla in its Home

In Quest of Gorillas

By Prof. William K. Gregory and Henry C. Raven. Pp. xvi + 241 + 110 plates. (New Bedford, Mass.: The Darwin Press, 1937.) 3.50 dollars.

IN the summer of 1929, a party of four scientific men, led by Henry C. Raven, of the American Museum of Natural History, left New York to visit the homelands of the gorilla in Africa. The doyen of the party was W. K. Gregory, the leading authority in all that relates to the structural history of anthropoids, living and extinct. The two other members were Prof. J. A. McGregor, known at home and abroad for his faithful reconstruction of extinct forms of humanity, and Dr. E. T. Engle, anatomist, Columbia University. The expenses of the expedition were paid by that University.

Coming by way of Europe, the expedition visited Brussels and Paris, where, after much cross-examination, permission was obtained to shoot five gorillas "for scientific purposes", two in the mountainous country to the west of Lake Kivu and three in the French Cameroon.

On August 4, 1929, the expedition pitched its camp on the western fringe of the great forest to the west of Lake Kivu and nearly 7,000 feet above sea-level. Their camp occupied a corner of the lands of an experimental farm; nothing can illustrate better than this the rapidity with which equatorial Africa is being transformed. The local gorillas proved to be the most elusive of animals; their tracks were everywhere, their nests or beds—often freshly made—were plentiful; dung, recently dropped, knuckle impressions in the mud, and broken and stripped twigs and branches marked the trail left by a passing group. The rustle of branches or a black arm moving amongst them, a bark or a grunt, a momentary glance of a moving form in the thick undergrowth proclaimed the vicinity of a group, but it took Mr. Raven six weeks of stalking to secure the two specimens of the Kivu gorilla. Prof. McGregor was ever ready with his camera; even after six weeks of patient and skilled waiting, not even a snap—much less a film—had been obtained.

The first gorilla shot by Mr. Raven—a male—weighed 460 lb.; with its litter—the total weight which had to be carried across twelve miles of country cut by ravines and clothed with thick brush—was 600 lb. This fact will give some idea of the toil which men of science are willing to undertake in the pursuit of knowledge.

On September 19 the expedition struck camp in the Kivu mountains and set out for the French Cameroon, which was reached on November 14. Africa was crossed from east to west by motor-car, river steamer and railroad, the route taken being that blazed by Stanley. The expedition pitched its new camp on the western fringe of the great Congo Forest. The western gorilla, which Dr. Gregory regards as the parent form, the eastern or Kivu being but a variety of the western, was just as elusive and as hard to come by in West as in East Africa. Day after day Mr. Raven followed roving bands, often hearing them but rarely obtaining a passing glimpse. When one district had been searched in vain, another was commended as an infallible source of supply. After spending five weeks in the French Cameroon without success, the party broke up. Mr. Raven was left to pursue the quest alone, the other members of the expedition being obliged to return to New York to resume their vocational duties.

The first part of this book is written by Dr. Gregory; he is an instructive and entertaining writer, but the chapters which hold the reader are those wherein Mr. Raven tells what he saw and what he felt while hot on the gorilla trail. Mr. Raven has served a long apprenticeship to jungle life in many parts of the world. He soon realized that if he were to succeed in the quest for gorillas he must live as natives live—and sleep where the gorilla sleeps: which he did, with the usual result—a devastating illness, one which almost cost him his life. He spent more than a year in the French Cameroon and ultimately obtained the three covenanted specimens.

Incidentally, much is to be gleaned from the pages of this book, which throws light on the habits of the gorilla. In the thick jungle, the gorilla has the advantage of man; when he observes hunters

crawling in pursuit, the gorilla must wonder how a being, so ill-adapted as man, ever came into existence. In spite of his enormous strength, the gorilla is a peace lover. He never sets out deliberately on the war-path; all his 'scraps' are accidental, the result of some man, woman or beast intruding into his family circle without giving sufficient warning. But when he has to fight, as when the group he leads is in danger, he shows always the utmost courage, giving his life when necessary. It is this instinctive trait which is the undoing of the male gorilla; he falls a victim when he turns to defend his flock. The natives assert that gorillas talk at night; the most that Mr. Raven could hear were noisy movements in their stomachs and a hissing—apparently an expiratory movement of the lips.

The real danger to which the gorilla and chimpanzee are exposed is not the hunter but the planter, native and European. Gorillas are destructive feeders when they invade gardens and plantations. They are also counted good to eat by most natives of West Africa. The total number of gorillas cannot be large; I doubt if there are 10,000 of them, even when western and eastern are added together. Prof. Gregory thinks they may be increasing their numbers in certain districts.

A. K.

Significance of the History of Science

The History of Science and the New Humanism By George Sarton. (Colver Lectures in Brown University, Elihu Root Lecture at the Carnegie Institution of Washington.) Pp. xx + 196. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1937.) 8*s*. 6*d*. net.

ONE welcomes especially any fresh utterance of Dr. Sarton on general lines, because he devotes himself too exclusively to the learned studies of which he is a master and speaks too seldom on the wider aspects and applications of those studies, on which he has so much to tell us. He is at the same time the most eloquent and convincing prophet of the value of the history of science as a discipline and the man best qualified on the history itself. It is a unique position and one envies the United States for possessing him.

In the volume under notice, Dr. Sarton publishes the substance of four comparatively popular lectures which he was invited to give by the Brown University and the Carnegie Institution of Washington. They are all full of inspiration and of good sense. Sarton does not overpress the claim for instruction in the history of science. He would even admit that it is not food for every palate. But he strongly and truly insists on its educational value as a central progressive and co-ordinating study, when taught by those who have an adequate preparation both in the sciences themselves and in general history, and applied by the learners in the same spirit. He makes the sound, though somewhat disquieting, remark that though there is no mental discipline so attractive and easy to receive, there is also none more difficult to impart. It is another case of the dominance of the specialist and the urgent need of more synthetically trained minds.

Of the four chapters, that on the relation of East and West and that entitled "The New Humanism" contain the freshest material and the most interesting detail. Dr. Sarton points out most seasonably that there should be no rivalry between West and East in the building up of science, for the creative movement was reciprocal. The East lit the first torch, which we know from recent discoveries in Babylonia and Egypt to have been a much brighter one than was at one time supposed. Then the Greeks took it up and made the blaze which has since illuminated the world. But before the work of the Greeks had been recovered and extended in the modern world, the light had gone back again to the East and was tended for centuries by the Arabs and Indians until the early Renaissance in Europe.

There are some specially interesting particulars here as to the function of the Jews in this matter. They were for long the linguistic intermediaries between East and West, though, after the middle of the thirteenth century, they lost this position of linguistic and national isolation and tended to become—educationally—one with the nationals of the Western countries where they lived. Thus, when we come to Spinoza, "we do not count him any more as a Jewish philosopher in the sense in which we counted Maimonides or Levi ben Gershon. He is one of the founders of modern philosophy, one of the noblest representatives of the human mind, not Eastern or Western, but the two unified".

Dr. Sarton's remarks on the right programme for a 'humanist' education will also be read with profit. He denounces an artificial international language, thinks that mathematics is the true international medium, but that everyone should have a usable knowledge of at least two of the great world-tongues. Ancient languages must, by the press of new knowledge, be left more and more to the specialist.

F. S. MARVIN.

Tables Annuelles Internationales de Constantes et Données numériques :
International Annual Tables of Constants and Numerical Data. 9 : Electromotive Forces, by Prof. H. S. Harned ; Oxidation-Reduction Potentials, by G. Åkerlöf. Vols. 11–12 (1931–1936), Section 60. Pp. iii+45. 25 francs. 13 : Faraday Effect, by M. Schérer ; Magnetic Birefringence, Electric Birefringence, by Prof. A. Cotton and J. Rabinovitch ; Photoelectricity, by G. A. Boutry. Vols. 11–12 (Years 1931–1936), Sections 38–41. Pp. iii+11+12+7+10. 20 francs. (Paris : Hermann et Cie. ; New York : McGraw-Hill Book Co., Inc., 1937.)

PARTS 9 and 13 of vols. 11–12 of "Tables Annuelles de Constants et Données Numériques" cover the period 1931–36. In Part 9, dealing with electromotive forces, H. S. Harned gives a convenient summary of data on concentration cells without liquid junctions, which will be very useful to workers in this field. Among the items of particular interest are Harned's own work on the thermodynamic dissociation constants of weak electrolytes, that of L. F. Nims on amino-acids, and several examples of ionic equilibria in heavy water. There is also a table of recently determined standard electrode potentials. This section should be used in conjunction with Part 3, in which the activity coefficients, free energies, etc., derived from the measurements, are given. G. Åkerlöf gives a summary of oxidation-reduction potentials, including the considerable number of organic systems, some of biological interest, investigated during the period.

Part 13 deals with the Faraday effect (M. Schérer), magnetic and electric birefringence (A. Cotton and J. Rabinovitch) and photoelectricity (G. A. Boutry). The latter, which is probably of the greatest general interest, contains a table of recent determinations of the photo-emission thresholds and work functions of metals. Since the elucidation of the theory of the photo-electric effect by Fowler in 1931, it has been possible to evaluate the true work function corresponding to absolute zero, and a considerable number of such determinations have now been made, which are collected here. Other sections deal with the effects of thin films of alkali metals and of complex films on the photo-emission, and there is also a summary of the characteristics of commercial photo-electric cells.

Communication Engineering
By Prof. W. L. Everitt. Second edition. Pp. x+727. (New York and London : McGraw-Hill Book Co. Inc., 1937.) 30*s*.

AN excuse for yet another text-book on the electrical communication of information, that is, by electric wave-motion in space or along wires, is that it is a little better than its predecessors. This to a large extent is true of the present work, since the author's plan is attractive and the subject developed logically, as may be instanced by the general grouping of the chapters ; these are classification of impedance elements, linear bilateral impedances, unilateral and non-linear impedances, coupling between electrical circuits and free space, and coupling between electrical and mechanical circuits.

The reader must not be put off by these and many other strange literary expressions ; the subject is becoming so complicated that continual grouping of ideas is imperative. Nevertheless there is a number of prominent omissions, particularly as one is not warned of them ; phase compensation, for example, should be included for students to-day, for it is as important as the degenerative amplifier, the properties of which are clearly stated. The most useful network theorems are grouped at the beginning, which does not indicate their relative importance, but apart from this the text can be well recommended. L. E. C. H.

The Analysis of Engineering Structures
By Prof. A. J. S. Pippard and Prof. J. F. Baker. Pp. ix+554. (London : Edward Arnold and Co., 1936.) 30*s*. net.

THE final report of the Steel Structures Research Committee completed investigations of first-class importance that have had great influence on the treatment of steel building frames. Both authors of this book were members of that Committee, and they are to be congratulated on so ably incorporating this recent work in a students' text-book on structural analysis. One chapter gives a valuable summary of the main findings and design methods, but elsewhere, as in the chapter on structural connexions, full use is made of the detail investigations of the Committee.

The book as a whole deals comprehensively with the principles on which structural design is based, and the work is carefully classified, wide in scope and—even apart from the work of the Research Committee—up to date, a fact which is shown by the chapter on mechanical methods of stress analysis, although it suffers somewhat from an undue brevity. The book is a notable addition to English text-books on structural analysis and in several respects marks new standards.

The Truth about Vivisection
By Sir Leonard Rogers. Pp. x+182. (London : J. and A. Churchill, Ltd., 1937.) 5*s*.

THE anti-vivisection campaign is persistent, vigorous and clamorous, has ample funds (estimated at £40,000 a year) with which to promote its objects, and uses a variety of methods to do so. It is the aim of Sir Leonard Rogers in this admirable little book to present the reader with the whole truth of the matter. He discusses the working of the Act of 1876 controlling and limiting experiments upon animals, analyses the reports of the Royal Commissions on Vivisection, and describes the valuable results that have been obtained through experiments upon animals in the curative and preventive treatment of diseases, both human and animal. It is a book that everyone should study who desires to ascertain the truth about vivisection, and will be most useful to those who may have to combat anti-vivisection propaganda. R. T. H.

Pasteurization of Milk

By Prof. G. S. Wilson

TEN, or even five, years ago there was a very real cleavage of opinion among scientific workers in Great Britain on the value of pasteurization. In general, the physiologists and biochemists were afraid of the possible damage caused by heat to the nutrient substances in the milk, and were inclined to minimize the part played by milk in the spread of infective disease. Bacteriologists and public health workers, on the other hand, were becoming increasingly impressed with the danger of drinking raw milk, and, in the absence of any convincing evidence to show that the nutritive value of the milk was seriously damaged by mild heat treatment, they strongly favoured the extended use of pasteurization as a means of diminishing the amount of preventable disease.

To-day this cleavage of opinion is much less apparent—indeed, it would scarcely be an exaggeration to say that it no longer exists. The change has come about, as all similar changes in scientific opinion must do, as the result of increased knowledge. During the past few years, several studies have been made on rats, mice and particularly calves, which have agreed in showing that only a minimal amount of damage is caused to the nutritive value of milk by low-temperature pasteurization. In addition, the occurrence of repeated outbreaks of milk-borne disease, some of them accompanied by a relatively high mortality, has gone a long way to convince unprejudiced observers that tuberculosis is not by any means the only infection spread by milk to human beings. It is now recognized that cleanliness is not enough. The milk must also be safe—safe from the risk of spreading disease—if it is to be recommended more freely to supplement the inadequate or unbalanced dietary of certain sections of our population. In view of this increasing unanimity, it will probably be better to give a brief résumé of the evidence on which our present conclusions are based rather than to set out the pros and cons of pasteurization[1], and thus create the illusion of a difference of opinion that now no longer exists. For reasons of space, discussion will be confined to the nutritional and hygienic aspects of cows' milk pasteurized by the official holding process (145°–150° F. for 30 minutes, followed by cooling to 55° F. or below) and sold under licence. Not until these two aspects are fully understood is it profitable to consider the economic implications of compulsory pasteurization which play so large a part in practice in determining opposition to this measure.

The observations of numerous workers[2,3] agree in showing that pasteurization has the following effects. About 5 per cent of the lactalbumin is coagulated; the coagulation time by rennin is lengthened, but the casein clot formed consists of finer particles and is of a more open texture; there is a diminution in the soluble calcium and phosphate, estimated variously by different workers, but probably of the order of 5 per cent; there may be some loss of iodine through volatilization; there is some destruction, at present unmeasured but apparently small, of vitamin B_1; and there is some diminution in the vitamin C content, depending largely on the amount of previous exposure to light and on the presence of copper in the pasteurizing plant. Information on the effect of pasteurization on vitamin D is still deficient, but considering that vitamin D is even more resistant to heat and oxidation than vitamin A, it is improbable that any deleterious effect occurs. As against these positive changes may be set a number of negative findings. Thus it is found from feeding experiments on rats and calves that the biological value of the proteins is unaltered, that there is no detectable change in the availability of calcium or phosphorus, that there is no loss of vitamin A, and that the total energy value of the milk remains unaltered. Furthermore, recent carefully designed experiments on calves[4,5] in which alternate animals were fed for 8–12 weeks on raw and pasteurized milk from the same source, have failed to show any significant difference in growth between the two groups of animals. In each experiment the average percentage weight increase was slightly higher in the group of animals receiving the pasteurized supply, but the differences were such as might easily have occurred by chance variation alone.

In assessing these results in terms of human nutrition it must be remembered that, though cows' milk may be a perfect food for calves, it is not a perfect food for infants. It differs both qualitatively and quantitatively from human milk, and it is deficient in iron, copper, vitamin C, and often in vitamin D. The differences between raw and pasteurized cows' milk are very much less than those between cows' milk and human milk. Deductions, therefore, from animal experiments to

man must be made with great caution. Unfortunately, there is a dearth of direct observations to determine the comparative nutritive value of raw and pasteurized milk for infants and children. The only experiment of any size that is on record[6] yielded results which failed to show any significant differences between the two classes of milk. Pending the publication of further observations of this type, we must conclude on the basis of all the available evidence that the nutritive changes produced by pasteurization appear to be comparatively slight, and are such as can readily be made good by suitable supplements to the dietary.

Turning now to the hygienic aspect of pasteurization, we have at our disposal well-documented evidence to show the danger of drinking ordinary raw milk and the protection afforded by adequate pasteurization against milk-borne disease. It is calculated[7] that in 1931 there were 2,600 deaths in Great Britain from tuberculosis of bovine origin and more than 6,000 fresh cases of the disease. Since then our knowledge of the part played by the bovine tubercle bacillus in causing pulmonary tuberculosis has considerably expanded, and there is no doubt that if this calculation were to be made afresh the figures would have to be increased rather than diminished. Undulant fever is a less important disease, but something like 400 cases yearly appear to arise in Great Britain, mainly from milk-borne infection[1]. Of epidemic diseases records[1] are available of the occurrence in Great Britain during the years 1912–35 of at least 103 milk-borne outbreaks of scarlet fever, septic sore throat, diphtheria, typhoid fever, paratyphoid fever, dysentery and gastro-enteritis affecting over 11,000 persons. These figures take no account of epidemic diarrhœa, in the causation of which milk almost certainly plays a considerable part. Our knowledge of sporadic milk-borne disease, apart from tuberculosis and undulant fever, is very deficient, since milk is rarely suspected as a vehicle of infection unless large numbers of cases occur in a short interval of time over a limited area, but as further information accumulates on this subject, it seems likely that the case against raw milk will have to be weighted still more heavily.

Pasteurization, adequately carried out in properly designed apparatus, and conveniently controlled in practice by the phosphatase test, destroys all pathogenic organisms in milk and renders it safe for human consumption. The laboratory and field evidence for these statements is too extensive to quote in detail. Reference may, however, be made to the now well-known observations of Price[8] in Toronto, which have all the force of an *ad hoc* experiment. Briefly, she found that among 300 tuberculous children bacteriologically examined, 15 per cent were infected with the bovine tubercle bacillus. All of these had come from parts of Ontario where pasteurization of milk was not carried out. In Toronto itself, where pasteurization has been compulsory since 1915, not a single case of bovine infection was found, in spite of the fact that 26 per cent of the incoming pooled supply of raw milk before pasteurization contained living tubercle bacilli. Nearer home we may add the recent experience at the Hannah Dairy Research Institute gained during one of the calf-feeding experiments alluded to above[5]. Of 36 calves fed for twelve weeks on raw milk, no fewer than 24 were found, when slaughtered, to be infected with the tubercle bacillus and to have macroscopic lesions of tuberculosis, whereas of 37 calves fed on milk from the same source after holder pasteurization, not a single one appeared to be infected. Apart from tuberculosis, the value of pasteurization in protecting against epidemic disease is well demonstrated by experience in the United States. Examination of the statistical returns shows that milk-borne disease has been practically eliminated from the large cities, where the great majority of the milk is pasteurized, and is now almost entirely confined to the rural districts and smaller towns, where most of the milk is consumed raw[9]. The effect of pasteurization in bringing to an end milk-borne epidemics that are already under way has been frequently and forcibly illustrated during the course of the past few years in Great Britain, notably in the extensive outbreak of typhoid fever at Bournemouth in 1936[10].

In view of this cumulative evidence it is not surprising that public health workers are asking for the control of milk-borne disease by compulsory pasteurization. From the hygienic point of view, this step is merely the equivalent to the treatment of water by filtration and chlorination. Recent experience has shown what widespread public disapprobation follows neglect to exercise adequate control over our water supply, and there seems no logical reason why the public conscience should not be similarly exercised over the safety of our milk supply.

It has been suggested that the right way to control milk-borne infection is to eradicate disease from our milking herds. While not depreciating for one moment the importance of this aim, it must be pointed out that pathogenic organisms may gain access to milk not only from the cow, but also from the human personnel, from the water supply, and possibly from rodents. Even if eradication of cattle disease within a generation or two were possible, it would still leave unsolved the problem of protecting the milk supply from these other sources of contamination.

Pasteurization, preferably accompanied by automatic bottling, alone affords an immediate, practicable, and effective method of ensuring the final safety of the milk as delivered to the consumer.

So far as the available evidence goes, there is no scientific argument against pasteurization. That the introduction of compulsory pasteurization might have widespread economic repercussions may be true, but it is not the purpose of this article to deal with a problem which comes into the domain of practical politics rather than of science. It is enough to show that, provided minor additions are made to the dietary of infants whose sole source of nourishment is pasteurized cows' milk—additions which are almost equally necessary on a dietary of raw cows' milk—there is no reason to fear that the growth and general development of our population would be in any way prejudiced by the extended use of pasteurized milk, while there is every reason to believe that the introduction of compulsory pasteurization, carried out under proper supervision, would lead to the practical abolition of milk-borne disease.

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Root-Pressure as a Factor in the Rise of Sap*

By Dr. Philip R. White, Rockefeller Institute for Medical Research, Princeton

THE history of our observations and theories—one can scarcely say our 'knowledge'—concerning the movement of sap in plants has been a rather tortuous one. Beginning with the 'vital' explanations of Hales[1] and Knight[2], in which the living cells were presumed to be the agents largely responsible for sap movement, our concepts have run the entire gamut to the 'mechanical' explanations of Dixon and Joly[3] and Askenazy[4] in which living cells were presumed to take no part in, or even to hinder, the movement of sap. The Dixon-Askenazy scheme is the one generally considered to-day to furnish the most satisfactory explanation of sap movement, while 'root-pressure', first observed by Hales in 1727, is looked upon as a transitory phenomenon, involving negligible forces (maximum value recorded, about 1·5 atm.), the occurrence of which in uninjured plants was subjected to doubt by Molisch[5], and hence probably unimportant.

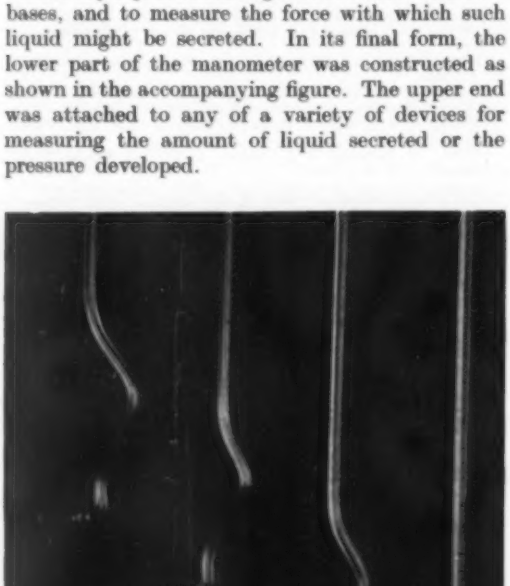
For a number of years, I have been growing excised roots *in vitro*, isolated from all the influences which the rest of the plant normally exert upon the root[6,7]. It has thus been possible to establish with a considerable degree of precision the nature of these influences. It has been shown that the tops of plants provide the roots not only with carbohydrates but also with amino-acids[8] and with materials[9] either identical with or capable of being replaced by at least one vitamin, B_1. On the other hand, roots are not absolutely dependent on the tops for hormones, as was once supposed. Most of these studies have been carried out on roots of tomato which have been maintained in continuous culture for about five years (250 passages). Roots of a number of other plants have also been studied. Those of aster (*Callistephus hortensis* Cass.) have been grown for about 100 passages, those of *Nicotiana langsdorffii* Weinm. for about 75 passages, those of *Brassica nigra* Koch, *Trifolium repens* L., *Petunia violacea* Lindl., *Fagopyrum esculentum* Moench, *Daucus carota* L., and *Helianthus annuus* L. for about 50 passages and those of a dozen more species for lesser periods.

The capacity to grow as autonomous units seems to be a general property of roots, at least among the dicotyledons. Now, one of the striking and universal features of these root cultures is that they retain their morphological characteristics, their growth polarity and their vascular strands. These strands are normally developed, although the cultures are grown floating upon, or immersed in, the liquid nutrient. Since in such cultures no obvious function could be ascribed to such strands, their presence seemed anomalous. If, however, a continuous flow of liquid be assumed to take place through these roots, that is to say, if they continue to function in culture in the manner postulated by Hales, as pumps, then the presence of vascular strands would be understandable. The root cultures seemed to offer a possible means of answering the old question: "Is root-pressure a real function

* Substance of a paper presented on December 28, 1937, before the Physiological Section of the Botanical Society of America at the annual meeting of the American Association for the Advancement of Science at Indianapolis, under the title "Root-pressure: An Unappreciated Force in Sap Movement".

of normal roots, or is it merely a wound reaction? And if root-pressure is real, what is its true magnitude?"

To answer this question, manometers were developed to receive single growing roots, to collect any liquid which might be secreted from their bases, and to measure the force with which such liquid might be secreted. In its final form, the lower part of the manometer was constructed as shown in the accompanying figure. The upper end was attached to any of a variety of devices for measuring the amount of liquid secreted or the pressure developed.



[Photograph by J. A. Carlile.

MANOMETER ASSEMBLY CONSISTING OF SPECIALLY DESIGNED GLASS TUBE, RUBBER HOSE AND METAL CLAMP. BY MEANS OF THIS ASSEMBLY, A SINGLE GROWING ROOT CAN BE ATTACHED TO A RECORDING APPARATUS AND THE FORCE WITH WHICH WATER IS SECRETED FROM ITS BASE CAN BE MEASURED. × ⅔.

Qualitative results of tests made with such manometers were presented a year ago[10]. It was shown at that time that a continuous unidirectional flow of liquid does occur through such roots, that over a period of several days the quantities of liquid secreted may represent many times the volume of tissue increase due to growth of the culture in the same period, and that this secretion may take place against considerable pressure. Since then some measurements of the magnitude of the secretion force have been made. Although no absolute value has been obtained for the maximum secretion force, the results appear to warrant discussion at this time.

Simple straight manometers 500 mm. long and filled with either water or mercury gave identical curves, plotting height of column against time. No diminution in secretion rate with increase in column height was observable, even under mercury (maximum pressure 500 mm. mercury = 0·7 atm.). Using a levelling bulb, pressures up to 1,780 mm. mercury (2 atm.) were imposed, again without appreciably retarding secretion. When the manometers were attached to a compressed air tank and pressures up to six atmospheres (90 lb. per sq. in.) were applied, the secretion curves obtained were still indistinguishable from those obtained without imposed pressure. At pressures greater than 90 lb. per sq. in. the apparatus failed. Apparatus is now ready which, it is hoped, will permit the study of secretion under still higher pressures; but no measurements have yet been made with it. It is noteworthy that the roots have at no time failed to secrete continuously against all pressures to which it has been mechanically feasible to subject them. Failures have all been due to the apparatus—not to the roots.

The detailed secretion curves show a striking diurnal rhythm, secretion being practically at a standstill during the night, beginning at about 6 a.m., reaching a maximum rate about noon, and then falling off in quantity, though apparently not in force, during the afternoon. Since the secretion rate was unaffected by pressures up to 6 atm., it is clear that the true secretion pressure must greatly exceed this value. It is my opinion that it must reach at least 10 atm. and is probably much greater than that. This value is for single, isolated, normally metabolizing rootlets of tomato, a plant which rarely attains a height more than a tenth that to which such a force is capable of lifting water. It is thus evident that 'root-pressure' is a very real phenomenon, and is by no means the insignificant factor which text-books have led us to believe. Failure to appreciate it in the past century has probably been due to the necessity, before the development of the root-culture technique, of working with traumatized, moribund and hence abnormally metabolizing materials.

It is not suggested that mechanical factors, such as transpiration pull, cohesion, capillarity, imbibition, etc., do not play a considerable part in sap movement. Under conditions of high transpiration, they probably do account for the movement of large volumes of water through the plant. But under certain conditions such, for example, as those existing during the rainy season in many tropical forests, some or all of these mechanical processes must cease to function. Under such

conditions, root-pressure, as demonstrated by these experiments, seems quite adequate to supply water to the tops of even the tallest trees.

No attempt will be made at present to explain how this force may be developed. We are interested, however, in determining if a diurnal rhythm of respiration rate exists corresponding to the observed rhythm of secretion, to extend the quantitative study of the phenomenon to roots of species other than tomato, including roots of some trees, and especially to extend the curve of secretion rate as influenced by imposed pressure far enough so that some estimate of the maximum secretion pressure can be obtained and compared with the osmotic values of the tissues involved. It is hoped thus to throw some light not only on the question of sap movement but also on the mechanism of secretion.

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Clay

FOR fifty years or more a number of people have been endeavouring to give a satisfactory answer to the question, "What is clay?" Instead of a simple answer which meets all requirements, no adequate definition has been found. Geologists define as clay many substances which potters would reject. Chemists look for a definition based on chemical composition and fail to obtain satisfaction because many commercially useful 'clays' differ so greatly in composition that no satisfactory correlation seems possible. The highly plastic blue clay used by glove manufacturers seems to have little in common with the hard grey fireclays of the Coal Measures and even less with the china clays of Devon and Cornwall, or the kaolin of the text-books. Plasticity—which is supposed by many people to be the chief characteristic of all clays—is almost absent from some kaolins the composition of which causes them to be regarded as the purest of all clays and the 'typical clay-substance' of numerous authors and investigators. On the other hand, many substances become plastic when suitably treated, though their compositions are so different from any kind of clay that the inclusion of plasticity as an essential part of any definition has often led to confusion.

An important step forward was taken when Seger succeeded in separating extremely small particles of almost constant composition from several varieties of clays used in the manufacture of bricks, tiles, and pottery. Further investigations along this line seemed to show, however, that Seger's 'pure clay' or 'clay-substance' does not exist in the sense that 'pure silica' or any other 'pure' chemical compound exists. The variations in composition and properties of the 'purest clays' obtained from various sources differed too greatly for clay to be regarded as a definite chemical compound.

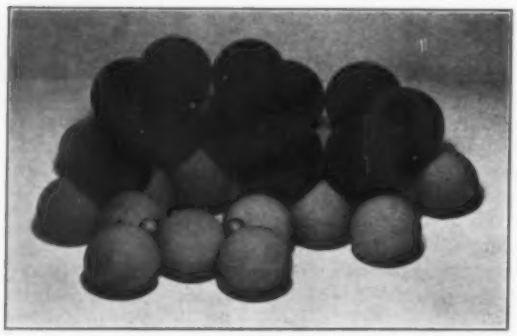
The whole subject remained in this inchoate state until a few years ago, because the 'purest' clay particles obtainable are so small as to be, for the most part, outside the range of the most powerful microscopes. Many seem to be readily converted into the colloidal state, if they do not exist in it when found, and as their precise shapes cannot be ascertained by direct observation they were regarded as amorphous. It seemed, indeed, as though the limits of investigation, as applied to clay particles, were rapidly being approached when a new line of research was opened out by the discovery that X-rays enabled the crystalline form of substances to be recognized even when the particles were of sub-microscopic dimensions. This line, so ably developed by Sir William Bragg and his son W. L. Bragg, has now changed the whole outlook on the constitution of clays and has successfully revealed the principal features of the structure of clays, though many details still await explanation.

The present position was described on November 19 by Sir William Bragg in a Friday evening discourse at the Royal Institution and may be summarized as follows:

Many mineral and other silicates have been found, by X-ray analysis, to consist of sheets or layers of atoms piled one upon the other, much as a series of balls of different sizes may be placed in a pre-arranged heap (see accompanying illustration). In both complex silicates and clays, the atoms (represented as spheres at the apices of tetrahedra) form a pattern of rectangular cells or units, and the various sheets or layers must

fit perfectly in combination even if they differ slightly when in separate existence. Such differences are easily overcome when two or more layers are laid on each other or when they grow together. The lengths of the sides of these imaginary rectangles have been measured, and from them the probable structure of various clays deduced.

The structure of the halloysite crystal (which is a characteristic constituent of some fireclays) has been determined by Mehmel, and the dimensions (in angstroms) of the unit (rectangular) cell are $a = 5{\cdot}20$, $b = 8{\cdot}92$, $c = 10{\cdot}25$, and $\beta = 100$. The value of c corresponds to four oxygen or hydroxyl sheets piled on one another. The structure of several typical clays and other minerals is shown in Table 1, each sheet or layer being enclosed in a rectangle of dimensions $a \times b = 5{\cdot}2$ A. $\times$ $8{\cdot}8$ A. The height of the cell depends mainly on the number of sheets and on their thickness.



ARRANGEMENT OF THE ATOMS IN A SHEET OF HYDRATED SILICA. THE O-ATOMS FORM THE LOWEST LAYER; THE OH-GROUPS, SHOWN DARKER, REST ON THEM. THE SILICON ATOMS OCCUPY THE SPACES BETWEEN; TWO SILICON ATOMS HAVE BEEN MADE VISIBLE BY THE REMOVAL OF OVERLYING SPHERES.

It should be noted that when halloysite is slightly heated, its two middle sheets of hydroxyl collapse into one sheet consisting of four oxygens and two hydroxyls. Four oxygens and eight hydrogens are expelled in the form of water, though no water, as such, exists in the clay. This expulsion of 'combined water' has long puzzled chemists, though they were aware that it originated in the decomposition of hydroxyl groups. As shown in Table 1, the slightly heated halloysite (meta-halloysite) has the same structure and composition as kaolinite and, presumably, as kaolin and china clay. Further heating of halloysite and kaolinite appears to result in the formation of free alumina and free silica, and the expulsion of water as steam, but further investigation is necessary to prove this.

Several well-known clays appear to be derived from, or closely related to, montmorillonite, which, as shown in Table 1, consists of two sheets of silicon atoms with a sheet of aluminium atoms and two sheets of oxygens and hydroxyls between. The greater thickness of the montmorillonite cell, as compared with pyrophyllite and mica, is attributed to further intervening sheets of water. The structural analogy of montmorillonite with hydrated silica, brucite, and gibbsite is clearly shown in the table.

TABLE 1.

Hydrated silica	Brucite	Gibbsite	Halloysite	Kaolinite
4 OH 4 Si 6 O	6 OH 6 Mg 6 OH	6 OH 4 Al 6 OH	6 OH 4 Al 6 OH 4 OH 4 Si 6 O	6 OH 4 Al 4 O + 2 OH 4 Si 6 O
	thickness = 4·73	thickness = 4·86	thickness = 10·25	thickness = 7·2

Pyrophyllite	Montmorillonite	Mica (Muscovite)
6 O 4 Si 4 O + 2 OH 4 Al 4 O + 2 OH 4 Si 6 O	6 O 4 Si 4 O + 2 OH 4 Al 4 O + 2 OH 4 Si 6 O water layer or layers	6 O 3 Si + Al 4 O + 2 OH 4 Al 4 O + 2 OH 3 Si + Al 6 O 2 K
thickness = 9·4	thickness = 9·2–21·4	thickness = 10·0

In Sir William Braggs's opinion, the main problem of the constitution of clays has now been solved: there are only two different groups of clays: (*a*) those allied to halloysite, kaolinite, nacrite, and dickite; and (*b*) those allied to pyrophyllite, the latter including montmorillonite, beidellite, bentonite, and fuller's earth, which differ chiefly in their metal contents, for example, in the extent to which gibbsite is replaced by brucite.

The suggested structures explain the colloidal properties of the smallest clay particles, the relatively 'enormous' effect of minute additions of alkalis or acids to clay pastes and suspensions, and they aid greatly in explaining variations in plasticity. Recent measurements by Bradley, Grim and Clark[1] have shown the existence of a well-defined set of hydrates in which the *c* axis increases regularly with the water molecules introduced into the unit cell. The looseness of these water molecules gives easy movement to the clay particles and yet prevents the complete loss of shape of the mass.

This peculiar ability of absorbing water molecules and arranging them in successive sheets in the layer-like structure of the clay crystal, causing

an increase in the c axis but not altering the lengths of the a and b axes, is, according to Sir William Bragg, "the cause of plasticity". The same structural arrangements also explain the remarkable property of 'base exchange' of some derivatives of montmorillonite clays (zeolites).

To sum up, the structures of the chief clay minerals shown in Table 1 enable clear, reasonable and simple explanations of the chief properties of clays to be formulated. Many details remain to be added, because it is difficult to obtain perfectly pure materials and because of the complications due to the numerous substitutions which are usually present. Now that the general structure of clays has been so clearly elucidated, it should not be difficult to fit the details into their proper places.

All who are interested in the molecular structure of clay, whether theoretically or in connexion with the manifold uses of this very important material, should be very grateful to Sir William Bragg for his masterly solution of a problem which has, for so long, baffled many men of science.

A. B. SEARLE.

[1] *Z. Kryst.*, **97**, 216 (1937).

Obituary Notices

Sir R. F. Johnston, K.C.M.G., C.B.E.

WE regret to record the death of Sir Reginald Fleming Johnston, formerly commissioner for Wei-hai-wei and a distinguished Chinese scholar, which took place in Edinburgh on March 6 at the age of sixty-four years.

Johnston, who was educated at the University of Edinburgh and Magdalen College, Oxford, where he obtained a second class in the Final Honour School of Modern History, entered the Civil Service of the Hong-Kong Government in 1898 as a cadet. After serving as private secretary to the Governor and acting clerk to the Council and Assistant Colonial Secretary, he was appointed in 1904 secretary to the Government of Wei-hai-wei, then held under lease by the British Government. He remained there until 1919, when his special and profound knowledge of China and the Chinese led to his appointment as tutor to the Manchu Emperor P'u Yi, now the ruler of Manchukuo. This appointment came to an end with the flight of the Emperor in 1924. In 1926, Johnston was appointed secretary to the British Indemnity Delegation, and in the following year returned to Wei-hai-wei as Commissioner, his appointment coming to an end with the transfer of the territory to the Chinese Government. On his retirement, when he was already a C.B.E. and C.M.G., he was promoted to K.C.M.G.

On his return to England, Johnston accepted the chair of Chinese at the School of Oriental Studies in the University of London, an appointment which he held from 1931 until 1937.

As a Chinese scholar, Johnston's knowledge of the language and the people, of their ways of thought and their beliefs, was exceptionally wide, deep and sympathetic, although in this last respect it was distinctly perceptible that his understanding grew and mellowed as time went on. When he left Hong-Kong for Wei-hai-wei, he had already acquired no little insight into the widely varied conditions of life and the character of the peoples of the Far East. He made two extensive journeys of which the first in 1902 traversed Tonking, Yunnan, the Chinese Shan States, the States of the Upper Laos and the plain of eastern Siam, ending at Bangkok. A later and more ambitious journey occupied nearly a year, during which Johnston lived for the most part in close touch with native life. This journey was described in "From Peking to Mandalay". On his transfer to Wei-hai-wei Johnston found himself in the Province of Shantung in close touch with the springs of all that is most traditional and changeless in the life of the Chinese peasantry. His studies here bore fruit in his scholarly and informative "Lion and Dragon in Northern China" (1910). This was followed in 1913 by his "Buddhist China", a sympathetic study of Chinese religious belief and philosophic thought, while his "Letters to a Missionary" (1918) affords a contrast in its trenchantly critical tone. "Twilight in the Forbidden City" (1934) records his experiences as tutor of the Emperor, whom he visited in Manchukuo in 1935, before proceeding to Mukden for the purpose of studying the archives of the Manchu.

Major F. G. Jackson

MAJOR FREDERICK GEORGE JACKSON, the Arctic explorer who died on March 13, was born in 1860 and educated at Denstone College and the University of Edinburgh. Attracted by an open-air life, he spent some time on a Queensland cattle ranch before the Arctic regions attracted his attention. A few months on a whaler in the Greenland Sea whetted his appetite and he offered his services to Nansen for the voyage of the *Fram*. But the *Fram's* complement was full and so Jackson decided to organize his own expedition. His plan was to attempt to reach the Pole by sledging north from Franz Josef Land, beyond which he, among others, believed that there existed a land which Payer, in 1873, had called Petermann Land.

In order to test equipment and to gain experience, Jackson decided first to undertake a winter journey in Arctic Russia. He began with a journey through the little-known Waigatz Island and then, failing to achieve his plan of exploring Novaya Zemlya, he

set off from Khabarova with a Russian, a few Samoyedes and reindeer sledges over the frozen tundra via the Pechora River to Archangel. From there he went on round the White Sea and across the Kola peninsula to Kirkenes in Norway. His book, "The Great Frozen Land" (1895), is full of notes on natural history and on Samoyedes' customs and folk-lore. With the backing of Mr. A. C. Harmsworth (later Lord Northcliffe), Jackson left for Franz Josef Land in 1894 and made his base at Cape Flora. The Franz Josef Archipelago was little known beyond the few discoveries of Payer and Leigh Smith. Jackson remained three years in the north, surveying some of the little-known islands and distinguishing himself as a hunter of polar bears, of which he shot about a hundred. Among his companions were W. S. Bruce and A. B. Armitage, who in later years distinguished themselves in South Polar work. The expedition's chief claim to fame was due to the chance meeting of Jackson with Nansen and Johansen. On their return from their long poleward march they had wintered on the north of the archipelago, and in 1895 were on their way west toward Spitsbergen when near Cape Flora they met Jackson, a few weeks before the *Windward* was due. Thus they reached Norway in safety.

After serving in the South African War of 1899–1902, Jackson contemplated a South Polar expedition but his plans came to nothing. He served in the Great War, and in 1919 had charge of Russian prisoners-of-war camps in Germany. Then in 1925 he turned to Central Africa for adventure and big game shooting, crossing Africa from east to west, visiting the Ruanda country and descending the Congo to the sea. Later he investigated the slave trade of Liberia. In addition to his book on Lapland Jackson wrote "A Thousand Days in the Arctic" (1899) and "The Lure of Unknown Lands" (1935). He was a gold medallist of the Royal Geographical Society, a medallist of the Royal Humane Society and a knight of the Order of St. Olaf.

Jackson's work was essentially of a pioneer order, and it was the opportunity to overcome physical difficulty and danger which drew him to the Arctic and later to Africa. Scientific exploration attracted him less than hunting, but he showed much interest in natural history and, where scope was afforded, in native races and their ways. R. N. R. B.

Prof. Anton Lampa

THE academic career of Prof. Anton Lampa, who died in Vienna on January 28 at the age of seventy years, was under the shadow of the political changes occurring in Austria during his lifetime. Educated in Vienna, he studied physics under von Lang and became *Privatdozent* and assistant professor in the University of Vienna. In 1909 he was called upon to fill the chair of experimental physics at the German University in Prague; when, in 1918, Czechoslovakia became an independent State, the German University in Prague came under the authority of the new Government instead of the Ministry of Education in Vienna. Although this did not cause any appreciable change of its activities, and almost all of the professors continued their work, Lampa decided to return to Vienna. Since there was no chair available for him there he again became *Privatdozent* of physics.

This resignation was no doubt facilitated by the variety of Lampa's interests. In experimental physics his name is connected especially with the production of very short electric waves; for several years he held the 'record' with a wave-length of 4 mm. He was much interested in questions of the philosophical foundations of science; here he was a devoted follower of Ernst Mach, and a short biographical sketch which he dedicated to Mach's memory is one of the best introductions into the latter's philosophy. The fact that, already in 1883, Mach, on general principles, had postulated the relativity of every type of motion (including rotation!) enabled Lampa to be one of the earliest to realize the whole significance of Einstein's theory of relativity. It was largely due to Lampa that the German University of Prague was the first to offer to Einstein a full professorship; he held there the chair of theoretical physics from 1911 until 1912, being in close touch with Lampa.

After his return to Vienna, Lampa devoted much time to educational questions. The various societies for the propagation of knowledge could always count on his support, and for a while he was president of one of them. His memory will be held in honour not only by his professional colleagues but also by many others who shared his literary or philosophical tastes and were aware of the sincerity of this very quiet and unostentatious man. F. A. P.

Mr. A. E. Munby

BY the death of Alan E. Munby on January 19, a great personality has been lost to the world of science and art. Mr. Munby's association with the cause for the advancement and development of science teaching for its intrinsic educational value is well known to many. He was for more than thirty years a member (twice chairman) of the Science Standing Committee of the Royal Institute of British Architects, and no effort did he spare in this capacity in obtaining from scientific and educational bodies all over Great Britain, their views, criticisms, and comments on scientific matters and the manner of their propagation. It is to be regretted that he has not lived to see the full benefits of his labours in this respect.

Mr. Munby was educated at Repton. His early training at Durham, where he was assistant to Prof. Bedson and lectured on chemistry in the adjoining counties, his engagement in research at Cambridge (under Sir Arthur Shipley), and at Heidelberg, and in science teaching at Durham, and Felsted School, well fitted him for that sphere of the profession of architect (which he took up at the age of thirty years) for which he is better known. There is no doubt that while a science master at Felsted opportunities

occurred to him for considering the practical aspect of the planning of science laboratories which led eventually to an interest in architecture.

It is natural therefore that Mr. Munby's principal works as an architect should lean towards science. Many public schools have had the benefit of his experience. He was responsible for the new science buildings at Clifton College, Highgate School, Beaumont College, University College of North Wales at Bangor, Gresham's School, Hereford Cathedral School, Shrewsbury School, Dover College, and for redesigning the science departments at Uppingham and Cheltenham, and at the Chelsea Polytechnic. He acted also as consultant for the Institute of Tropical Medicine in Shanghai, and for the recently erected science department at Malvern College.

Mr. Munby's publications include: "Notes on Polarised Light" (1894), "Introduction to the Chemistry and Physics of Building Materials" (1909), "Laboratories, their Planning and Fittings" (1921), and "School Laboratory Fittings" (1929).

J. R. S.

Mr. M. W. Hilton-Simpson

WE regret to record the death of Melville W. Hilton-Simpson, anthropologist and African traveller, which took place on March 17 at the age of fifty-seven years.

Hilton-Simpson was the son of the Rev. William Hilton, who added Simpson to his surname in 1888; he was educated at Wellington and Exeter College, Oxford, where he obtained the degree of B.Sc. and the diploma in anthropology. On leaving Oxford, he specialized in the study of African ethnology in the field, making his first journey in North Africa and the Sahara in 1903. His next expedition was to West Africa with Émil Torday as leader, and Norman Hardy, the artist. This ethnological expedition, of the first importance as it proved to be, was carried out on behalf of the British Museum. It covered much unmapped territory in the Kasai basin of the Congo, and brought back valuable anthropological information relating to the tribes of the area, especially the Bushongo, a rich collection of ethnographical specimens, more especially examples of the art of the Congo peoples, and a gallery of paintings by Norman Hardy, which were as remarkable for their accuracy in representing the physical characters of the people, their dress and ornament, as they were for their high artistic merit.

Hilton-Simpson's interests, however, centred not so much in tropical Africa as in the ethnological problems of the northern area of the continent, and more especially in the Berber peoples. For a number of years, each season found him travelling in North Africa, while from 1912 onward he specialized still further in the study of the Algerian Berbers. Seven winters in succession were spent in travelling in the Aurès mountains, where the sporting tastes of himself and his wife established friendly relations with a sporting people and won them exceptional facilities for their investigations. Mrs. Hilton-Simpson's skill as a hockey player not only secured her a place of pre-eminence in the Shawia women's national game, but also gave her their intimate confidence, to the lasting gain of ethnological science.

The work of these years of travel was recorded in "Among the Hill-Folk of Algeria" and "Arab Medicine and Surgery", and in papers in the *Geographical Journal*, the publications of the Royal Anthropological Institute and elsewhere. An especially important contribution to the study of these peoples was a series of cinematograph films of Berber life and industry, taken by Mr. J. Haessler, an American anthropologist, who accompanied them on certain of their expeditions. Apart from his general account of these peoples, Hilton-Simpson's most valuable contribution to the study of their culture was his investigation of their practice of trephining. He made a collection of the instruments used for this purpose, and showed that, like a number of other elements in their culture, the practice was to be traced back to Roman times.

Hilton-Simpson, who served on the Western Front in the Great War and held the rank of captain, was a Chevalier of the Légion d'Honneur and was awarded the Rivers Medal of the Royal Anthropological Institute for anthropological work in the field in 1932.

Lady Gomme

BY the death of Lady Gomme, which took place on January 5 at the age of eighty-five years, folk-lore studies in Great Britain have lost a staunch supporter of long standing. With her husband, the late Sir George Laurence Gomme, whom she, as Alice Bertha Merck, married in 1875, she took a prominent part in the early activities of the newly constituted Folk-Lore Society, of which they were among the founders. Throughout their married life, and after her husband's death, her organizing ability, her knowledge of her subject and its personnel, and her keen critical faculty, gave her, as of right, a foremost place in every movement for promoting the recording and scientific study of folk beliefs, customs and institutions. Lady Gomme helped to found the two societies, now merged, devoted to the study of folk-dance and song, and strongly influenced the late Sir Cecil Sharp in his work of collecting folk-songs and dances. She herself was the author of two works, which have long been regarded as standard books of reference and models of their kind—"Children's Singing Games, with the Tunes to which they are Sung" (1894, Second Series, 1895) and "A Dictionary of British Folk-Lore, Vol. 1: Traditional Games of England, Scotland and Ireland" (Pt. 1, 1894; Pt. 2, 1898).

WE regret to announce the following deaths:

Mr. F. G. L. Bertram, deputy director of civil aviation from 1926 until 1935, on March 24, aged sixty-two years.

Capt. T. S. Taylor, founder and a director of Taylor, Taylor and Hobson, Ltd., manufacturing opticians, on March 14, aged seventy-four years.

News and Views

Solar Radiation as a Cause of Ice Ages

THE supplement to this week's issue of NATURE (p. 591) consists of Sir George Simpson's discourse at the Royal Institution on "Ice Ages". The striking advances of great ice sheets over large areas of the globe which have occurred at long geological intervals have attracted a great deal of attention from geologists, who have described their extent, oscillations and associated phenomena in a huge volume of literature, and there has been much speculation, some of it very wild and baseless, as to their causes, but they have been little discussed from the point of view of physical meteorology. With so much ground to cover in a short time, Sir George Simpson presented the geological results in broad outline, ignored the speculations, and concentrated on the theory of variations of solar radiation as a cause of ice ages which is his own especial contribution to the subject, built up by a number of important researches during the past few years. It has previously been assumed that widespread glaciation required a general fall of temperature, one cause of which might have been a *decrease* of solar radiation; Sir George demonstrated on physical grounds that glaciation is more likely to result from an *increase* of solar radiation. This would have little effect on temperature, but would cause increased snowfall in high latitudes and at the same time heavy rainfall ('pluvial periods') in lower latitudes. That such a paradoxical state of affairs is actually possible was shown by a simple and beautiful experiment in ice formation performed at the discourse and illustrated in the text.

Further Evidence relating to Peking Man

IN another column of this issue of NATURE (see p. 614) Prof. Franz Weidenreich describes further discoveries relating to Peking man—fragments of femora and part of a humerus. These were extracted from material excavated in the cave of Choukoutein in July last, shortly before further investigation was abandoned on the approach of hostilities. For the actual discovery science is once more indebted to the care and skill as an investigator of Mr. W. C. Pei, by whom the first *Sinanthropus* skull was discovered in the Choukoutien cave in 1929. In view of the fact that little skeletal material of *Sinanthropus* has been discovered in the cave, apart from skulls and teeth, the latter now numbering well over a hundred specimens, the new material is of no little importance, as Prof. Weidenreich shows, both in the light it throws on the build and carriage of this early member of the human family, and also for purposes of comparison with other forms. Thus, for example, Prof. Weidenreich deduces from the larger of the two femoral fragments, which he argues to be feminine, that as reconstructed, it points to the stature of its former owner having been approximately five feet, indicating a stature in the male of five feet four inches. Further, the characters of the leg bones and the humerus agree in indicating that, while the femur presents certain primitive characters, which are enumerated, distinguishing it from that of recent man, nevertheless Peking man walked upright. It is possible that in this respect *Sinanthropus* had the advantage over Neanderthal man. The upper limbs had been completely relieved from the function of locomotion. This freedom of the upper limb would accord with the relatively advanced character of the stone industry which has been discovered in the cave. In other respects the new evidence throws further light on the culture of Peking man. The scorching of one of the bones corroborates previous evidence that *Sinanthropus* had attained the use of fire, while the way in which the bones have been broken—the illustration suggests that they have been hacked off by a stone implement—points in the same direction as the evidence of the skulls—to cannibalism.

Dr. Adolf Mahr

THE Court of the University of Edinburgh at a meeting held on March 22, appointed Dr. Adolf Mahr to be the Robert Munro lecturer in anthropology and prehistoric archæology for 1938–39. This lectureship was founded in memory of Dr. Robert Munro, most distinguished and widely-known of Scottish archæologists, whose work on palæolithic man and on the lake dwellings of Europe placed him in the front rank of the students of prehistory of the late nineteenth and early twentieth centuries. The choice of Dr. Mahr as Munro lecturer at the present juncture is peculiarly appropriate. Born and educated in Vienna, after holding an appointment on the staff of the Imperial (now State) National Museum of Vienna, when he specialized in studies of the Hallstatt period of the Iron Age, Dr. Mahr in 1934 was appointed director of the National Museum of Ireland and keeper of Irish antiquities. In virtue of his office, the responsibility has devolved upon him of adapting to the service of field archæology the State measures of the Irish Government for the relief of unemployment and economic depression. A large number of men have been absorbed in the work of excavating on occupation sites of all periods of Irish history from prehistoric to late historic throughout the country. A measure of these activities in archæological research, which have been pursued under the direction of Dr. Mahr and supervised by him and his assistants, is afforded by the summary of results which formed the substance of the address delivered by Dr. Mahr

as president of the Prehistoric Society in 1937, and occupies no less than 175 pages in quarto of that Society's recently published *Proceedings* for 1937 (3, 2).

Royal Geographical Society: Medals and Awards

H.M. THE KING has approved the award of the Royal Medals as follows: Founder's Medal to Mr. John Rymill, for his organization and leadership of the British Graham Land Expedition 1934–37; Patron's Medal to Mr. Eric Shipton, for his explorations around Nanda Devi and Mount Everest and his conduct of the Shaksgam Expedition of 1937. The Council has made the following awards: Victoria Medal to Mr. A. R. Hinks, for his contributions to the study of geodesy and the figure of the earth, map projections, and photogrammetric survey; Murchison Grant to Mr. Martin Lindsay, for his journey across Greenland in 1934; Back Grant to Mr. Thomas Hay, for his contributions to the physical geography of the Lake District; Cuthbert Peek Grant to Mr. Bradford Washburn, for his explorations and glacier studies in Alaska; Gill Memorial to Mr. Ivan Champion, for his explorations and surveys in Papua.

The British Association and Australia

THE Australian Government has decided not to proceed further at present with the proposal to invite the British Association to meet again in the Commonwealth. As it is desired, however, that leading men of science should from time to time be afforded opportunity to visit Australia, it has been decided to issue invitations to a party of six to attend the jubilee meeting of the Australian and New Zealand Association for the Advancement of Science at Canberra in January 1939. It is hoped that the precedent so set will become regular practice at each succeeding biennial meeting of the Association. A grant of £A1,500 towards the expenses of the guests in 1939 has been promised by the Government.

Man and Animals in Great Britain

A MEETING arranged by the University of London Animal Welfare Society (ULAWS) was held in the Beveridge Hall of the University of London on March 22 to discuss "Man's Relation to Nature and his Response" with reference to "the Survey and Regulation of British Fauna". The chairman, Sir P. Chalmers Mitchell, said that the so-called 'balance of Nature' is a myth and has not existed since glacial times, when there were no animals in Britain to be balanced. We interfere too much for there to be one and interference is no good without knowledge. The Marquess of Tavistock showed how conflicting interests make legislation difficult. Fruit farmers and the owners of grouse moors oppose the protection of bullfinches and peregrine falcons respectively. There is no need to fear the introduction of wild birds for, unlike alien rodents, they find competition too strong. As regards method of control, there is no difficulty in shooting deer in the Highlands, but in the wooded Lowlands hunting is kinder. Shooting is often unkind to foxes owing to the uncertainty of aim. Otters are neutral in sporting streams, killing some game fish but keeping down eels; but they are harmful in trout hatcheries and to ornamental wild fowl. Protecting stoats and weasels to keep rabbits down is a fallacy. Prof. F. A. E. Crew referred to the need for research on the ecology of British mammals; he suggested that we should have something like the U.S. Biological Survey, that the Bureau of Animal Population should be supported, and the staffs of museums and university departments should be enlarged. Sir Roy Robinson, chairman of the Forestry Commission, said that complaints about his treatment of animals were sentimental and not based on knowledge. Rabbits should be exterminated. There are too many deer and foxes. The only mammal in need of protection is the pine marten, and he would like to harbour them. All birds, except black-game and caper-cailzie, should be encouraged in forests. Other speakers referred to the desirability and the difficulties of rabbit extermination in various parts of Great Britain.

Roman Fortifications in Yorkshire

RECENT evidence of the varied methods of construction adopted by the builders of Hadrian's Wall (see NATURE, March 19, p. 505) lent additional interest to the account of the defensive system of Roman Aldborough, near Boroughbridge, Yorkshire, which was presented to the Society of Antiquaries on March 24 by Mr. J. N. L. Myres and Miss Mary Kitson Clarke. This site, known to the Romans as Isurium Brigantium, was the capital city of the British tribe of the Brigantes, an important people, whose territory covered nearly the whole of the northern part of what is now England south of the Border. The excavation was carried out by Mr. Myres and Miss Clarke for the Roman Antiquities Committee of the Yorkshire Archæological Society. In the course of the excavation, it was found that the north-west wall did not run as shown in the Ordnance Survey map, but that its angle lay farther to the north-west. The main scheme of the defences, it was found, consisted of the wall itself, backed by a bank of clay and sand. This, however, was not constructed until the second century A.D. Previously there appears to have been no system of defence, and Roman occupation had been haphazard. Later, perhaps in the early part of the fourth century, a large bastion had been added to the angle, and at least one small bastion built on to the west wall, not far from the angle. Still preserved to a height of nine feet in parts is the lower story of an internal angle tower, which was a striking feature of the wall in its original form. This had supported some structure rising above the wall. Pottery indicates that a lean-to hut at the back of the tower was occupied in the third century. The excavations will be carried further in the coming season.

Clifton College Scientific Society

THE Clifton College Scientific Society held a conversazione in the Science School on Thursday, March 17. About 350 guests were present, as well

as approximately the same number of members of the Society, but the spacious laboratories were not more than pleasantly full. Among the exhibits and experiments, arranged by the boys themselves, were a cathode ray oscillograph, a model geyser, fluorescence in ultra-violet light, a model of a hydraulic ram, the preparation of artificial silk, Bristol's share in the development of chemistry, chemiluminescence, flames and explosions, the effect of plant hormones, living elvers from the Severn, and experiments upon animal respiration. Lectures upon colour and upon liquid oxygen, with demonstrations, were given by two members of the Society, and a third entertained visitors by chemical conjuring performed to the accompaniment of an almost professional patter. The aeronautical section—a comparatively new but already vigorous branch of the Society—staged a topical exhibit of aeroplane parts, including a collection of bombs, while in the Science Library were displayed many scientific classics and autographs of famous men of science. Some of the original quartz glass, made by W. A. Shenstone while at Clifton, was on exhibit in one of the corridors, where a collection of the elements, arranged by a former member of the Society when still at school, also attracted much attention. One of the most popular features of the evening was a *tableau vivant* of Lavoisier and his wife, after the well-known picture by David. Among the guests were Sir John Inskip, Profs. M. W. Travers, W. E. Garner, C. M. Yonge, R. J. Brocklehurst, A. Rendle Short and A. M. Tyndall, Air Commodore Dalzell-McKean, and the head masters and science masters of many neighbouring schools.

Acquisitions at the British Museum (Natural History)

THE British Museum (Natural History) has received as a donation from Lord Sudeley the skins of three *Colobus* monkeys from Mount Kenya, *Colobus polykomos kikuyuensis*. One of the specimens is of exceptional interest, being nearly a full albino, the only black hairs remaining being a few scattered hairs on the back and a small V-shaped marking on the crown of the head. These specimens came from close to Nanyuki, situated on the equator on the western slopes of Mt. Kenya at an elevation of about 8,000–9,000 ft. These white or semi-white Colobus monkeys apparently belong to one family group, as they are all found in one very restricted locality on Mt. Kenya. Lord Sudeley shot the specimens himself and reports that the eyes were of normal colour and not the eyes of an albino. Lord Moyne has presented to the Museum the zoological collections made by M. J. Delacour and Mr. J. S. Colman during the recent cruise of his yacht *Rosaura*. These include material from the coast of Greenland, southwards to the West Indies, Brazil and the coast of West Africa. The collection when worked out will probably prove of prime importance for several distinct branches of zoological inquiry. The Royal Society has presented a set of specimens of the volcanic rocks of Montserrat in the West Indies, collected by Mr. A. G. MacGregor, who was a member of the Royal Society Expedition which visited the island in 1936 to investigate the causes of the recent earthquake activity and its relation to the vulcanology. A piece of meteoric iron, found last year at Kumerina in Western Australia, has been presented by the Public Library, Museum and Art Gallery at Perth. A polished specimen of 'Brazilian onyx', an ophicalcite worked in the Argentine, has been presented by Messrs. John Bolding and Sons, and the Cookson Lead and Antimony Company has presented a remarkably fine specimen of metallic antimony crystals.

Rubber Technology Conference

A RUBBER TECHNOLOGY CONFERENCE, under the auspices of the Institution of the Rubber Industry, has been arranged to take place in London on May 23–25, under the honorary presidency of Sir William Bragg. The Conference is being supported by the leading organizations connected with the rubber producing and manufacturing industries and by many other scientific and technical societies; altogether, some seventy organizations in Great Britain, Canada, South Africa, British Malaya, Ceylon, the United States, Austria, Belgium, France, Germany, Holland, Italy and Poland will be sending official delegates to the Conference. These include the Research Association of British Rubber Manufacturers and many of the other industrial research associations operating under the Department of Scientific and Industrial Research. More than seventy papers have already been promised from authors representing most of the countries just mentioned. This excellent response promises to make the Conference an outstanding event, at which a notable gathering of rubber technologists and scientific men interested in rubber from at home and over-seas is expected. A special feature of the Conference will be a symposium on methods of improving and evaluating the durability of rubber, but all other aspects of rubber science and technology will be covered by the remaining sessions. An attractive programme of social events, visits, etc., is being arranged. Those desiring to become members of the Conference or to contribute papers can obtain full particulars from the Secretary, Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.

Oil in Osage County, Oklahoma, U.S.A.

A FIELD party of the United States Geological Survey has recently investigated sub-surface geology of the Osage Indian Reservation of Oklahoma, and it appears that there are many localities in this Reservation worthy of exploration from the point of view of oil production. Prior to the issue of the Geological Survey's report, a paper had been written by N. W. Bass, W. R. Dillard, and J. H. Hengst (U.S. Department of the Interior. *Bull.* 886, A) describing several of these localities. In the east-central part of the Reservation, it is believed there may be an oil pool of considerable extent in the Bartesville Sand. Three productive wells have already been drilled. One drilled thirteen years ago had produced 63,000 barrels of oil by the end of

(*Continued on p. 599*)

NATURE

SUPPLEMENT

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Ice Ages*

By Sir George Simpson, K.C.B., F.R.S.

IT is now common knowledge that there have been great changes in climate during past ages. The geological evidence is perfectly clear that luxuriant vegetation once grew in Greenland and Spitsbergen, where now the hardiest forms of vegetable life can barely exist on the small areas free from permanent ice. At the other extreme, there is no doubt whatever that at one period a great ice sheet covered the plains of Central India and discharged icebergs into a sea covering what is now the Punjab and North-West India—one of the hottest parts of the earth.

From the geological record it would appear that the climatic changes of the past were in all directions, some warmer and some colder, some wetter and some drier than at present; and some individual localities appear to have experienced all possible climates at one time or another.

It is the problem of meteorologists to study the extent and sequence of the climatic variations in all parts of the world and to seek the cause and mechanism of the changes. Very little progress has been made in that direction up to the present for two main reasons. In the first place, the geological evidence is very fragmentary and often doubtful; and secondly, we know very little of what causes climatic variations and how they are controlled.

The geological evidence of change of climate is based on the fossil relics of past vegetable and animal life and on the physical effects which climatic conditions have on the surface rocks. The former is very difficult to interpret. Heavy vegetation does not always mean warm damp conditions, and both plants and animals may, in the course of ages, change their habits so that the early representative of a species which is now warmth-loving may have been developed in cold surroundings. For this reason, one cannot be certain of climatic conditions deduced from the remains of vegetable and animal life.

The case is quite different when we base our climatic deductions on the physical features of old land surfaces. There can be no doubt when we find traces of salts left when an enclosed sea has dried up that we are dealing with a dry climate in which the rainfall was less than the evaporation. But of all evidences of climate those of ice are the most unmistakable. At the same time one has to be careful, for to-day the presence of ice does not always mean a cold climate. In mountain regions glaciers descend the valleys into climates which are far from arctic, and in New Zealand especially ice action is taking place in valleys which bear an almost subtropical vegetation. There have been periods in the past when ice formation was much more active than at present and of such an extent that only a radical change in climate can have been responsible.

The evidence of the presence of ice during these periods in places where ice is quite impossible with the present climate is so clear that these Ice Ages, as they are called, are the most appropriate subjects for the study of climatic change. If we can find a cause for an Ice Age we shall have made a long step forward towards explaining all changes of climate.

* Friday Evening Discourse delivered at the Royal Institution on December 10, 1937.

Pre-Cambrian Ice Age

In the early days of geology, when evidence of tropical vegetation was found in regions which are now far from the tropics, it was supposed that the high temperature required by these plants was due to the earth still remaining hot from its earlier molten state. The discovery, however, of clear evidence of ice in Pre-Cambrian times, that is, at a time far anterior to the appearance of vegetation, shows that the earth had by then already cooled to its present temperatures. Evidence of Pre-Cambrian ice has been found in North America, Europe, China, South Africa, India and Australia. Some geologists have concluded from this widespread evidence of ice that the Pre-Cambrian Ice Age was extremely severe. So little is known, however, about this early age, and there is no evidence that all these places were glaciated at the same time, that it is useless to try to reconstruct the climatic conditions which then existed. The only certain conclusion is that already stated, namely, that the temperature of the earth was then already sufficiently low to allow of ice formation.

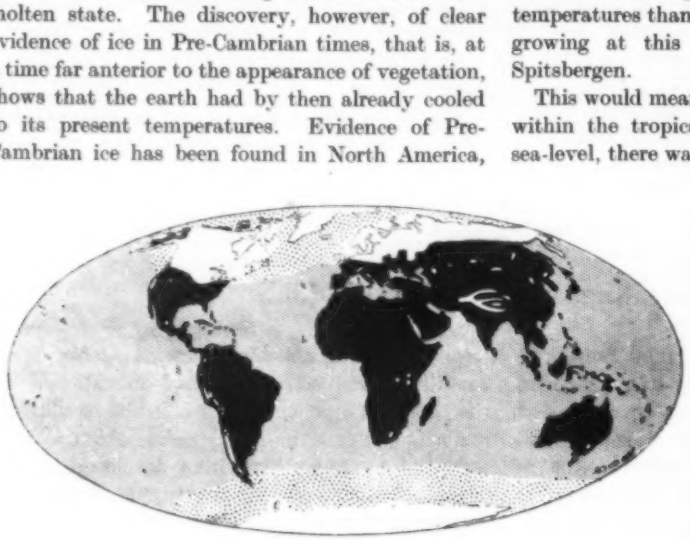

Fig. 1.

Pleistocene glaciation: ice on land shown white, ice on sea shown by light stipple.

Permo-Carboniferous Ice Age

After the Pre-Cambrian Ice Age, there is little or no evidence of extensive ice until towards the end of the Carboniferous Period or the beginning of the Permian Period, when evidence of extensive ice appears. This period is called the Permo-Carboniferous Ice Age. The chief regions where the ice was extensive and the evidence undoubted are in South America, South Africa, Australia and India. The latter is well within the tropics, and the evidence is perfectly clear that an extensive ice sheet existed at sea-level in the Central Provinces, India. It is of great importance to notice that, so far as the evidence goes, the ice at this time was all situated within 40° of latitude of the equator, and mainly in the southern hemisphere. Most geologists consider that at the same time the north polar regions had much higher temperatures than at present, luxuriant vegetation growing at this time in both Greenland and Spitsbergen.

This would mean that while there was glaciation within the tropics leading to vast ice sheets at sea-level, there was an almost subtropical climate in polar regions. This is a reversal of the climatic belts which no meteorologist can accept. Owing to the shape of the earth, the equatorial belt must always be warmer than the polar regions. The only explanation the meteorologist can give—and it was given by Wegener—is that the continents were not then in the same position relative to the pole as they now occupy. In other words, the continents have moved since Permo-Carboniferous times.

The Pleistocene Ice Age

After the Permian Period, there was another long stretch of time without any marked evidence of ice. This interval includes the whole of the Secondary and Tertiary divisions of geological time.

Evidence of ice was not entirely absent during this period, but geologists are of the opinion that the climate of the world as a whole was warmer than at present. In any event there was nothing equivalent to the extensive ice fields which left their traces in the Pre-Cambrian and the Permo-Carboniferous Periods.

The Tertiary ended with the Pliocene Period, when without doubt the climate of Europe was definitely warmer than at present. Towards the end of the Pliocene Period the temperature commenced to fall in Europe, and evidence of ice made its appearance. Some time between the end of the Pliocene Period and the present time, that is, geologically speaking, during the Pleistocene Period, there was a great extension of ice in all parts of the world.

The map (Fig. 1) shows the area which was under ice at some time or other during the Pleistocene Period. The north polar ice cap extended outwards, reaching latitude 38° N. in North America, 50° N. in Europe, and 60° N. in Asia. In the British Isles the ice sheet extended as far south as the Thames Valley but did not cross it. The ice covering of the Antarctic was then much thicker than at present, and Meinardus estimates that the flow of ice from the Antarctic continent into the surrounding seas was at least three times as much as at present.

Not only were the polar ice caps more extensive and thicker, but also the mountain glaciation was much developed and the glaciers reached much farther down the valleys. The evidence shows that this was so in all parts of the world. Not only were the mountains which now carry ice more heavily glaciated, but also many mountains which now carry no permanent ice had extensive glaciers upon them.

Detailed study of the deposits left behind by the ice shows that there was more than one advance and retreat of the ice during the Pleistocene Period. Glacial and interglacial epochs have been detected in all regions which were glaciated, both in regions covered by the extended polar ice caps and on the glaciated mountains. The history of the Pleistocene glaciation has been most completely studied by Penck and Brückner in the Alps. The result of their work is summarized in Fig. 2, which is a reproduction of their classical diagram showing the variation of the height of the snow-line in the Alps during the Pleistocene Period. From this diagram it will be seen that Penck and Brückner concluded that the snow-line descended far down the mountains on four occasions, the limits reached each time being practically the same, namely, about 1,500 metres (4,000–5,000 feet) below the present snow-line. They gave the names: Gunz, Mindel, Riss and Würm to the four glacial epochs. It will be noticed that the four glacial epochs occur in pairs—the Gunz with the Mindel and the Riss with the Würm—with a rather longer interglacial epoch between them.

There is no certain evidence that the history of the ice worked out in the Alps applies to other parts of the world; but meteorological considerations make it very improbable that there were different glacial histories for each part of the world; and as the evidence of glacial and interglacial epochs has been found wherever the glacial history of a country can be worked out in detail, one is justified in concluding that these epochs occurred simultaneously as the result of a world-wide cause.

This conclusion is becoming more and more accepted by glaciologists as they work out the sequence of the glacial epochs in their own regions,

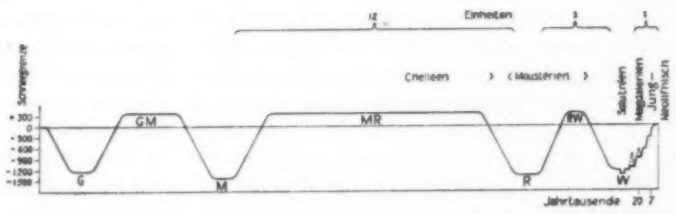

Fig. 2.

PENCK AND BRÜCKNER'S DIAGRAM OF HEIGHT OF SNOW-LINE IN ALPS DURING THE PLEISTOCENE ICE AGE.

and a meteorologist cannot accept any other conclusion. In the sequel, therefore, we shall consider that the glacial history of the Alps is representative of the glacial history of the world as a whole.

The advance and retreat of the ice must have been accompanied by large variations in the climate. When a country such as Great Britain was invaded by an ice sheet, the climate must have been that of the polar regions to-day, and the fossils of plants and animals leave no doubt that such was the case. The climate during the interglacial periods, however, is much more interesting and unexpected. One would not have been surprised if the climate during the temporary retreat of the ice had remained cold and unpleasant. The evidence, however, is quite clear that in some, if not all, the interglacial epochs, the climate became warmer and more genial than to-day. At Hötting, in the Alps near Innsbruck, fossil leaves have been found of a rhododendron which grows to-day only in Portugal and the Caucasus, where the temperature is higher and the rainfall greater than it now is in Hötting; in the rivers of Europe (including the Thames) the shells of freshwater molluscs are found which now survive only in rivers such as the Nile, the temperature of which is 10° C. higher than that of the European rivers of to-day; and on the coasts of Holland and

Denmark, beds of sea shells were deposited containing species eighteen per cent of which to-day only occur south of the Bay of Biscay.

There is still considerable controversy as to which of the interglacial epochs these finds should be referred; so that we do not know whether all the interglacial epochs had warmer and wetter conditions than are experienced to-day. But there can be no doubt that in one or more of the interglacial epochs the climate not only returned to present-day conditions but also became warmer and wetter.

Outside the areas which were invaded by the ice—the so-called glaciated regions—we must look to other records than those of ice to give us information regarding the changes of climate which occurred there during the advance and retreat of the ice. In non-glaciated regions it is difficult to find traces of changes of temperature; but changes in rainfall leave clear records in river deposits and in the levels of lakes with small or no outlets. From such evidence there is no doubt that there were long and pronounced periods of heavy rainfall during the Pleistocene Period in practically all parts of the world.

In North America the Great Basin, which is now an arid, sandy desert, was full of water, and the small existing intensely salt lakes were vast sheets of water to which the names Lake Bonneville and Lake Lahontan have been given. According to Gilbert and Russell, these lakes were twice filled during the Pleistocene Period, thus indicating that in North America there were two pluvial periods.

Wayland has reached the conclusion that in Uganda there have been two pluvial periods, one near the beginning of the Pleistocene Period and one towards the end; between these two pluvial periods the climate was much drier than it is to-day. Huzayyin has also recognized two major pluvials during the Pleistocene in south-west Arabia.*

Pluvial periods were not confined to tropical and subtropical regions, for in the Swanscombe Gravels we have evidence of a much greater Thames than exists to-day. The *Corbicula fluminaris* contained in these gravels show that they were laid down during an interglacial epoch when the temperature was considerably higher than at present.

Practically all deserts such as the Sahara, Libyan and Kalahara show signs of water action in relatively recent times, and many of them are littered with the flint tools of prehistoric man, showing that in the latter half of the Pleistocene Period they supported sufficient animal life to make them good hunting grounds.

It is probably too early to say definitely that in all parts of the world there were two pluvial periods, but the evidence is very strong, especially in North America and Africa.

The climatic conditions during the Pleistocene Ice Age may be summed up as follows:

The Pleistocene Ice Age did not consist of a simple advance and retreat of the ice but of a sequence of glacial and interglacial epochs. Based on observations in the Alps, there were four glacial epochs separated by three interglacial epochs. During some at least of the interglacial epochs the climate was warmer and wetter than to-day. In regions not subjected to glaciation there is evidence of two great pluvial periods, one early and one late in the Pleistocene Period, separated by a long interval during which there was even less precipitation than at present.

Cause of the Pleistocene Ice Age

A very large number of theories have been propounded to explain the cause of the Ice Age. It is becoming more and more generally accepted that no change located in the earth itself—such as a change in the distribution of land and water—or in the earth's atmosphere—such as a change in the amount of carbon dioxide or volcanic dust—can explain the sequence of climatic changes associated with the Pleistocene Ice Age, and we are being thrown back on to changes outside the earth. The most obvious source of climatic change would appear to be solar radiation. This seems such a simple solution. If we assume that the sun's radiation can change, all climates would appear to become possible: an Ice Age would be produced by reducing the radiation and a warm period by increasing it. Unfortunately, things do not go in this simple way. As the result of a study which I made a few years ago to find what happens to the solar radiation when it falls on the earth, and how the earth returns to space the energy which it receives from the sun, I was led to the conclusion that the last Ice Age was not caused by a decrease of solar radiation but by an increase! I must now try to explain this paradox.

The sun sends out a stream of energy which we call sunshine. The earth intercepts a quantity of this energy which on absorption warms up the surface and the atmosphere. If the earth had

* Nature, **140**, 513 (1937).

been a 'black body' it would have warmed up to a temperature, which can be easily calculated, when it would have emitted just as much radiation as it received from the sun. In this way the temperature of the earth would have increased and decreased with an increase and decrease of the solar radiation. One of the first results of my investigation was to show that the earth does not react to changes in solar radiation like a 'black body'. I was able to show that if the solar radiation were to increase, the temperature of the earth's surface would not increase to anything like the extent that one would expect from the increase of solar radiation; but that the cloud would increase and return the greater part of the additional solar radiation without warming up the surface of the earth.

In this way the balance between the incoming and outgoing radiation is maintained more by the amount of cloud than by the temperature. In present conditions just about half the sky is covered by cloud; the amount is slightly different in the different latitudes, but not to any large extent. The clouds appear bright because they reflect the sun's light. The light which the clouds reflect cannot be used to warm up the earth; it is just returned to space, and to that extent the solar radiation is reduced. The amount of solar radiation returned directly by the clouds has been measured and proves to be 43 per cent of the total incoming solar radiation. That is, nearly half the solar radiation which reaches the earth is intercepted and returned by the clouds without taking any part in warming up the earth.

We will now consider what happens to the radiation which reaches the earth. Because of the shape of the earth, more solar radiation falls per square foot on the surface at the equator than at the poles. The equator is therefore maintained at a higher temperature than the poles. This difference of temperature causes differences of pressure in the atmosphere, and a circulation of air is set up between the equator and the poles. This is called the general circulation of the atmosphere; and all winds ultimately can be traced back to differences of temperature, mainly those between the equator and the poles.

In the course of time the atmospheric conditions reach a steady state with a certain temperature distribution, a certain amount of air motion and a certain amount of cloud, which combined are just sufficient to cause a balance between the incoming and outgoing radiation.

Now let us consider what would be the effect of increasing the solar radiation by a specified amount. At first the increased radiation would reach the earth's surface and warm it up, but on account of the shape of the earth the equator would be warmed up more than the poles. Hence the difference in temperature between the equator and the poles would be increased and this would lead to an increase in the general circulation of the atmosphere. The increased temperature and the increased wind cause an increase in the amount of water evaporated from the oceans. This increased water in the atmosphere leads to greater formation of cloud and, as the precipitation must equal the evaporation, to an increase in precipitation also.

The increased cloud, however, reacts on the solar radiation and reflects an increased proportion of it. The final state is a new balance between the incoming and outgoing radiation produced mainly by the increased amount of cloud, the only temperature change being that necessary to produce the greater amount of cloud.

Different parts of the world will be affected differently by these changes. In equatorial and temperate regions where the precipitation all falls as rain, the effects of increasing the solar radiation are simple: there is a slight increase of temperature and a general increase of rainfall. Thus the most important effect of increasing and decreasing the solar radiation is to increase and decrease the precipitation, and the two keep step with one another: a period of increased solar radiation is always a period of increased rainfall and vice versa.

When, however, we approach the poles, where the precipitation may be either in the form of snow or rain, the conditions are much more complicated and must be studied in more detail.

Let us fix our attention on a region where at present the summer temperature does not rise above the freezing point, so that there is little or no summer melting of the ice—the Antarctic is such a locality. Now let the solar radiation increase. In consequence, the precipitation and the mean annual temperature both increase, as indicated by Curve I of Fig. 3. At first all the precipitation is in the form of snow, but when the summer temperature approaches the freezing point—say, at *A*—some of the summer precipitation falls as rain. Curve II represents the annual snowfall, and as the radiation increases beyond the point marked *A* the curve for snowfall falls increasingly below the curve for the total

precipitation. Curve III represents the evaporation and summer melting combined. At first there is no melting, only evaporation, but after *A* melting becomes more important, and at *B* the loss of ice through evaporation and melting equals the total snowfall. Curve IV in the lower half of the diagram represents the annual accumulation of snow; it is obviously the difference between Curves II and III. At first, the annual accumulation of snow is small; as the solar radiation increases, the accumulation of snow increases until it reaches a maximum, after which it rapidly decreases, owing to the rapid increase in the amount of melting. Finally, in spite of the greater total precipitation and large annual snowfall, the melting is so great, especially in the summer, that no accumulation at all takes place.

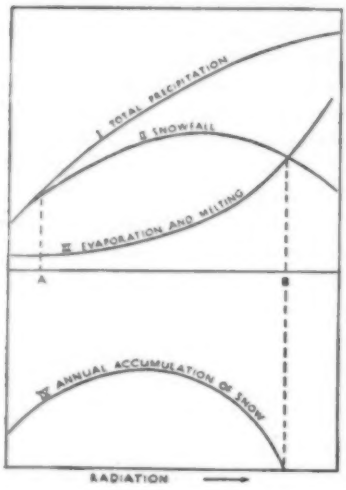

Fig. 3.

EFFECT OF INCREASING RADIATION ON PRECIPITATION AND ACCUMULATION OF SNOW.

Although it may seem strange that an increase of temperature can produce increased glaciation, it may be demonstrated by a simple experiment. In four identical glass jars (Fig. 4) each containing a layer of water in the bottom and a metal vessel at the top which can be cooled by solid carbon dioxide, the water at the bottom represents the equator and the metal vessel at the top the polar regions. One jar (second from the left) contains water at the temperature of the room and there is an appreciable deposit of ice at the top. By adding ice to the water in the vessel to the left, equivalent to lowering the equatorial temperature, the deposit of ice at the top is much reduced. The water in the third vessel has been warmed by a small gas jet, and the effect of the heating has been greatly to increase the deposit of ice. In the fourth bottle the temperature has been raised still higher, with the consequence that the ice has almost entirely disappeared by melting.

These four bottles can be regarded as representing increasing radiation as shown in Fig. 3. The first bottle has a low temperature (little radiation) and the ice deposit is thin, corresponding to *A* on the diagram. The second bottle has a higher temperature (more radiation) and therefore corresponds to a point to the right of *A* on Fig. 3 and shows a greater accumulation of ice. The third bottle represents the conditions where the ice deposit reaches its maximum, and the fourth bottle represents some point beyond *B* where the melting and evaporation exceed the deposit.

The conditions represented by Fig. 3 and the experiment apply to the polar regions and high mountains. At first an increase of solar radiation causes an increased accumulation of snow and ice in spite of increased temperature. During this stage, ice sheets form and glaciers advance, giving rise to a glacial epoch. As the radiation increases still further, the ice melts away and we have overcast skies and much precipitation but no ice accumulation. When the solar radiation decreases, conditions are reversed and the whole sequence is gone through in the reverse order.

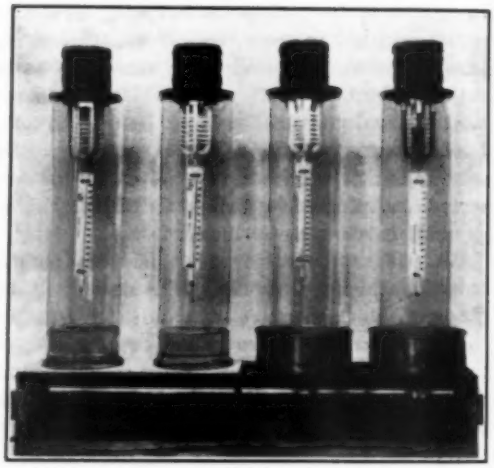

Fig. 4.

EXPERIMENT SHOWING EFFECT OF INCREASE OF TEMPERATURE ON AMOUNT OF ICE FORMATION. TEMPERATURE OF WATER AT BOTTOM OF BOTTLES INCREASES FROM LEFT TO RIGHT.

Fig. 5 has been prepared to show the sequence of changes of ice and meteorological factors when the solar radiation makes two complete oscillations. The abscissæ represent time increasing towards the right. Curve I represents two complete cycles of solar radiation and Curve II

represents the mean temperature of the world as a whole. Curve III is the curve of precipitation and therefore follows directly the curve of solar radiation. Curve IV is the curve of snow accumulation. As drawn, it shows some accumulation at the minima of the solar radiation, but a complete disappearance of the accumulation owing to increased temperature at the maxima of the radiation. The ice which accumulates year by year in the specified area must escape; if the area is a mountain top, the escape will be by way of glaciers; if it is a polar cap, the escape will be by an ice sheet spreading over the surrounding country. In either case the ice is transported into regions where the melting is greater than the snowfall, and the greater the annual accumulation the farther will the ice penetrate, down the mountain side if a glacier and into lower latitudes if an ice sheet. Curve V shows the advance and retreat of the ends of the glaciers or of the front of an ice sheet.

Examining the last curve, we see a close resemblance to Penck and Brückner's curve for the height of the snow-line in the Alps (Fig. 2). In each there are four advances of the ice. The advances are arranged in pairs, with short interglacials between the advances in the pairs, and the pairs separated by a longer interglacial. This arrangement comes from the fact that there are two glacial epochs for each maximum of the solar radiation. The interglacials have different climates according as they occur at the maximum or a minimum of the solar radiation. The former are warm and wet and the latter are cold and dry. We are at present approaching a minimum of solar radiation. In consequence our rivers are smaller and our temperature lower than they were in the last interglacial. We now see why there were only two pluvial periods in non-glaciated regions for the four glacial epochs in polar regions and on mountains. If the theory is correct, the last interglacial—the Riss-Würm interglacial—was a warm one, and to it the evidence for a warm wet climate which I have described above should belong.

Thus we see how two oscillations of radiation have produced in non-glaciated regions two pluvial periods, and in glaciated regions four glacial epochs separated by three interglacial epochs, two of which were warm and wet and one cold and dry. If the theory is correct, we are now living in a cold dry epoch owing to the decrease of solar radiation from its last maximum. If the solar radiation again increases, there will be another glacial epoch and our epoch will become a second cold dry interglacial.

An obvious objection to the explanation of the last Ice Age which I have given above is that with their present temperatures no amount of precipitation would result in the formation of an ice sheet over England and Scotland and still less over Ireland; yet we know that such ice sheets did

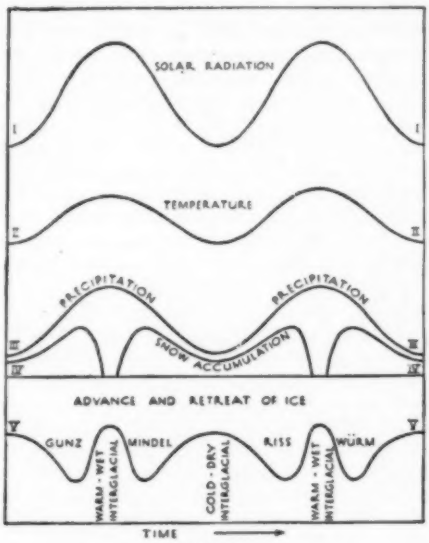

Fig. 5.

EFFECT OF TWO CYCLES OF SOLAR RADIATION ON GLACIATION.

exist. The objection is still stronger when it is remembered that the theory requires the increase of precipitation to be accompanied by an increase of temperature.

There is another problem which has puzzled everyone who has studied the cause of the Ice Ages. If we plot on a circumpolar map the limits of the ice sheet, we find that the area covered by the ice was not concentric with the North Pole. It extended much farther south over Europe and the east of North America than it did over Asia and the west of America; in fact the centre of the ice sheet was in the middle of Greenland, 20° of latitude from the Pole.

The answer to both these problems is the same and gives strong support to the correctness of the theory. If the area around the North Pole were land instead of sea, we should have at the Pole a great ice sheet, similar to that over Greenland and the Antarctic, rising many thousands of feet above sea-level. With increased precipitation this ice

cap would increase in height and extent and grow symmetrically about the Pole. With the present distribution of land and sea such a north polar cap is not possible. The ice which forms in the Arctic Ocean during winter breaks up in the summer and a certain amount escapes into the North Atlantic Ocean. At the maximum of a glacial epoch when the coasts around the Arctic Ocean were under ice, there would be a great flow of ice throughout the year into the sea. The whole Arctic Ocean would become packed with ice which would have to find an outlet somewhere. The Bering Strait between Asia and America is both narrow and shallow, and no appreciable amount of ice would escape that way. There was always, however, a wide, deep connexion between the Arctic Ocean and the Atlantic Ocean between Greenland and Norway. Through this passage icebergs and thick pack ice would move southwards, filling the North Atlantic with ice and lowering the temperature.

Fig. 6 has been drawn to illustrate this. The ice-covered area has been stippled and it will be seen at once that this area is not concentric with the Pole. The flow of ice on the land is shown by thin arrows. Ice flows into the Arctic Ocean from the northern coasts of America and Asia, and moves, as shown by the long thick arrows, into the North Atlantic, where it is replenished by ice from Greenland and Norway, and a stream of ice passing down Davis Straits joins it to the south of Greenland. The whole of the North Atlantic was filled with ice.

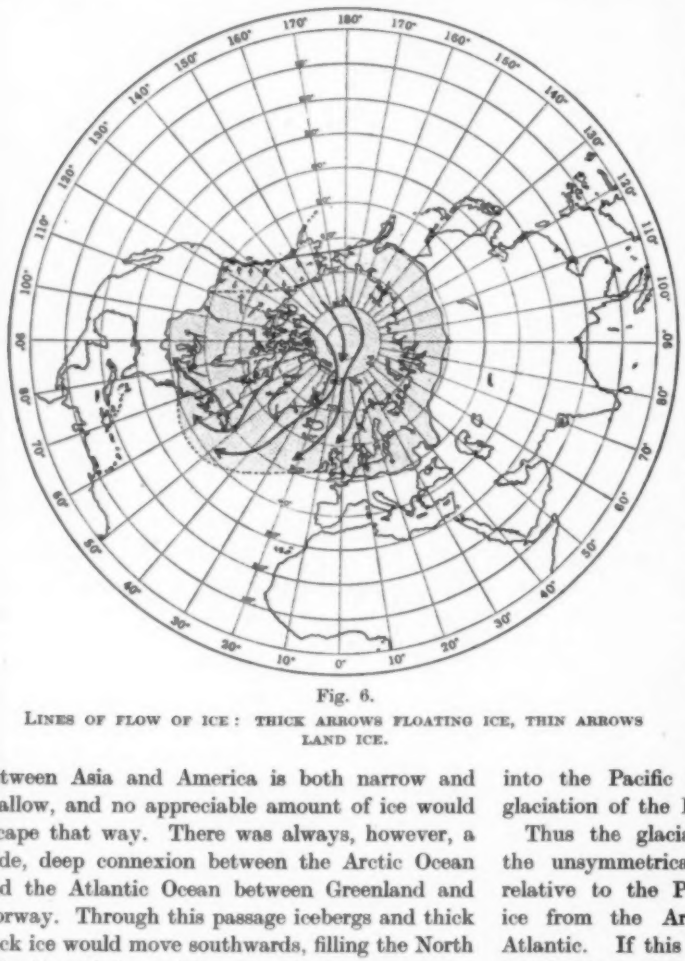

Fig. 6.

LINES OF FLOW OF ICE: THICK ARROWS FLOATING ICE, THIN ARROWS LAND ICE.

These conditions would have far-reaching effects on the climate of the British Isles and the adjacent parts of Europe. In the first place the Gulf Drift would no longer exist, so that instead of the western coasts of Europe being washed by relatively warm water they were washed by cold seas dotted with ice. In the second place the Icelandic depression would either cease to exist or would be displaced to the south, so that the warm south-westerly winds to which we owe our mild climate were replaced by cold north-westerly winds. With these large changes there is no wonder that ice sheets formed on the British Isles. On the American coast the winds would be north-east and drive the ice-laden water on to the American coast. Thus glacial conditions extended far to the south on both coasts of the Atlantic Ocean. As there was no corresponding flow of ice into the Pacific Ocean, there was no similar glaciation of the Pacific coasts.

Thus the glaciation of the British Isles and the unsymmetrical position of the ice sheets relative to the Pole were both due to flow of ice from the Arctic Ocean into the North Atlantic. If this connexion had not existed, the distribution of the ice would have been quite different.

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July 1936, and is still producing at the rate of approximately 10 barrels a day. Another situated half a mile south-east gave a 30-barrel show of oil in the Bartesville Sand in 1922; and a third, a considerable distance to the north-east of the other two, produced about 25 barrels of oil in 1921. The presence of productive oil sand in these three wells points to the probability that oil-bearing Bartesville Sand occurs in this district in a characteristic lens-shaped body. In addition, there are known to be in the Reservation two small domes, as yet untested, but structurally similar to two nearby domes producing from the Siliceous Lime. The productive domes are fairly typical of the oil fields, being of small extent but giving large yields. On one of these there are eight wells which have yielded oil, and on the other five. The approximate yield per acre of the former dome up to July 1936 was 6,964 barrels of oil, and of the latter, for the same period, 6,300 barrels. Recently, also, the rate of yield from both domes has been materially increased by treating the oil-bearing beds in the upper part of the Siliceous Lime with hydrochloric acid.

Plastics and Insulation

A JOINT meeting of the Institution of Electrical Engineers and the Plastics Group of the Society of Chemical Industry was held at the Institution of Electrical Engineers on March 24 to discuss a paper on "Plastics and Insulation" by L. Hartshorn, N. J. L. Megson and E. Rushton. It is largely based on an investigation carried out at the National Physical Laboratory and the Chemical Research Laboratory for the British Electrical and Allied Industries Research Association. Broadly speaking, a plastic is any material from which rigid objects of predetermined shape may be made by moulding processes. Their most characteristic property is that by suitable treatment they may be made to pass through a plastic condition, that is, a state between the solid and liquid states, like that of dough or damp clay. The property of hardening instead of softening on the application of heat is one of considerable practical importance to both moulders and users of plastics. It increases the working temperature of the material and improves its mechanical properties. It also allows the finished article to be removed from the mould while still hot. The primary function of an electrical insulating material (a dielectric) is to act as a barrier to the flow of electricity. Dielectrics always pass a leakage current, sometimes through the body of the material and sometimes over its surface. These currents can be taken as a measure of a defect of the material. With alternating current we have in addition an expenditure of energy due to the pulsating current in the dielectric. Polystyrene and polyindene, materials not yet produced in Great Britain, are hydrocarbon plastics, made in the form of clear glass, like solids, and are almost ideal for use in cables for high-frequency work; for example, in television, and in ultra-short-wave radio work, and in junctions for high-voltage cable work they are almost ideal.

Report on Street Lighting

DR. J. W. T. WALSH gave an introductory account to the Illuminating Engineering Society on February 8 of the final report of the Ministry of Transport Committee. It was then discussed by the Society and the discussion is published in the February issue of *Light and Lighting*. The members constituting the Committee were the chairman, four lighting specialists, two engineers associated with local authorities and two Government officials. Its final report was issued in November 1937. The Committee received evidence from several organizations and made inspections of a large number of existing installations. It also carried out experimental work on a special roadway (Lonsdale Road, Barnes) set aside for the purpose. The Committee classified roads into two groups only, *A* and *B*, and gave technical recommendations for each group. In the recommendations the Committee insisted on the importance of satisfactory maintenance and approved of lighting from dusk to dawn. Whilst it was recognized that special study of measures for the guidance of traffic during fog was necessary, it was urged that the general design of installations should not be prejudiced by special adaptation to fog conditions. The report also recommends that a formal specification for street lighting should be issued without delay by the British Standards Institution. In conclusion, Dr. Walsh showed a film of a lighted street just as it would appear in practice, in which various objects (persons stepping into the roadway, dogs, etc.) were continually coming into view and then disappearing. The number of such disappearances was stated to be fifty-six. But very few of the observers succeeded in identifying half this number. This showed the danger of bad lighting.

Journal of Neurophysiology

THE new *Journal of Neurophysiology*, under the editorship of Prof. Dusser de Barenne, J. F. Fulton and R. W. Gerard, made its first appearance in January. It is designed primarily to provide a means of publishing papers dealing with the experimental analysis of the phenomena of the central and peripheral nervous system, and descriptive neuro-anatomy and pathology are intentionally excluded. The publisher, Thomas of Springfield, Illinois, intends to produce a number every other month, and the editorial board undertakes to deal with submitted papers within one or two months of receipt. This accelerated publication is certainly desirable, as the existing channels for the publication of papers in this field in the United States are overcrowded, and there is an inevitable delay. The first number, of 55 pages, contains nine papers dealing, *inter alia*, with cerebral action potentials, effects of experimental cerebral lesions, degeneration of nerve, and changes in the salt content of nerves as a result of the transmission of impulses. The format is pleasing, and the standard of the illustrations is high. A little more uniformity in certain details is desirable; authors are cited in different papers either by numbers, by year or by an abbreviation of the year; the date of

receipt of papers is not always given. A more uniform lettering of the illustrations might also receive attention, and the adoption of a bold face type for the volume numbers in the lists of references would add to the ease of reading. These criticisms are, however, minor and are points which will probably be dealt with as the journal becomes more mature. The periodical certainly fills a need, and should serve, as the editors point out, actually to help to counteract undue subdivision in physiology by bringing together in one journal many divergent investigations on the nervous system.

Social Applications of Physics

IN an address on the "Social Applications of Physics" at a symposium at the University of Sydney on September 21, which was published in the *Union Recorder* (October 7), Prof. O. U. Vonwiller, pointing out that the man of science to-day must consider the bearing of his work on the problems of civilization and recognize his responsibility for some of the economic and social difficulties of the times, suggested these difficulties were due primarily to our inability to accommodate social and economic conditions to the rapidly changing methods of production following the application of scientific discovery. The main cause of these rapid changes was the changed status of the inventor, and while the success of the man of science as inventor had brought many real benefits to mankind, much distress had also arisen because in applying scientific discovery the first consideration was that of financial benefit. Prof. Vonwiller considered we could not continue to ignore ameliorating measures and suggested that the most promising method for dealing with the evils of over-production was to reduce the hours of employment. No satisfactory and lasting improvement in our difficulties could be expected, however, unless we adopted much from the methods of scientific investigation and discovery, with their honesty of inquiry and statement. In economic questions the difficulty of avoiding prejudice, however, was very great, and Prof. Vonwiller did not suggest that the adoption of scientific method would remove all our difficulties, though he appealed strongly for a courageous endeavour to understand and make understood the possibilities and limitations of scientific progress.

Twenty-fifth Anniversary of Laue Diagrams

LAUE first used his method of X-ray analysis of crystal structure in 1912. The twenty-fifth anniversary of this event has been celebrated by *Die Naturwissenschaften* by the publication of two interesting articles on the progress made in this branch of crystal chemistry. One, by F. Laves (*Naturwiss.*, 25, 705, 721; 1937), deals with the theory of the method and its development, and mentions its applications, particularly to the determination of atomic distances in crystals. A full account of our present knowledge of the radii of ions and atoms and their separations in crystals, and the dependence of these on the type of linking, is given, and there is a useful bibliography. The second article deals with the use of X-ray interference methods in the investigation of the fine-structure of animal tissues, and is contributed by F. O. Schmitt (*Naturwiss.*, 25, 709; 1937). It mentions particularly progress made in the examination of nerve, sinew and muscle, and other tissues in which there is a high degree of orientation of proteins or lipins. It will be recalled that *Current Science* also had special articles in connexion with this anniversary (see NATURE, 139, 517; 1937).

History of Science and Medicine

WE have received the fourth volume of *Osiris*, a journal edited by Dr. George Sarton and dealing with the history and philosophy of science. This volume is entitled "Incunabula Scientifica et Medica", by A. C. Klebs, and contains the titles of books on science and medicine printed up to the year 1500, with references to catalogues indicating where the books may be found. This list is very convenient to students of the history of science and medicine, since it contains information which was previously to be found only in large and expensive library catalogues. The volume is quite a substantial one, having 359 pages, so that it is evident that an unexpected range of material of this class was printed at an early period. In a book purporting to give accurate information on dates of publications, it is somewhat surprising to find the title-page dated 1938, whereas the volume was received in October 1937.

Proposed List of Current Geographical Publications

MORE than eight hundred technical and scientific periodicals are received by the library of the American Geographical Society. From these a careful selection of material of geographical interest is made, to be entered in the library's research catalogue. A current index is thereby provided to an extremely important body of geographical material that does not appear in the usual library catalogue. There is thus afforded a continuous, up-to-date record of current material of value not only to geographers but also to geologists, economists, anthropologists, and workers in many other allied fields. So useful has the research catalogue proved to the staff of the Society and to those consulting its library that the Society now proposes to make this material more generally available if there is sufficient demand. It is planned to publish ten mimeographed lists a year of the material catalogued during the month (material for July and August to be listed in the following issues). The subscription rate will be 3.75 dollars.

Fisheries Research in Australia

THE 138-ton motor ship *Warreen* (an aboriginal name for the sea), built for the fisheries section of the Australian Council for Scientific and Industrial Research, has been launched in Melbourne. The vessel will be used for the study of pelagic fish in the waters around Australia, commencing in the south-eastern seas. The headquarters of the section will be at Port

Hacking, some eighteen miles south of Sydney, on a reserve beautifully situated for the purpose. Plans have been drawn for a laboratory to cost £12,000, which should be finished by the end of the year.

International Society of the History of Medicine

THE eleventh Congress of the International Society of the History of Medicine will be held in Yugoslavia on September 2–11 at Zagreb, Belgrade, Serajevo and Ragusa. The stay at Ragusa will coincide with the birthday fête of the King, who will be patron of the Congress. The following subjects will be discussed: (1) the history of medicine in different countries, introduced by Prof. Gomoiu; (2) the history of malaria in the Balkan peninsula and especially in Yugoslavia; (3) natural history in popular medicine (animals, plants, minerals); (4) mystery and magic in popular medicine; (5) medicine in folk poetry; (6) psychogenic diseases and psychotherapy in popular medicine. Further information can be obtained from the general secretary, Dr. Vladimir Bazala, Vlaska Ulica 95, Zagreb, or from Dr. Guiart, 58 Boulevard de la Croix Rousse, Lyon.

Schools and the Way to Peace

AN international conference of teachers to be held in London on April 22–25 is being organized by the Education Committee of the League of Nations Union. It is intended to re-examine the whole question of 'peace teaching' in the schools in view of recent changes in the international situation in Europe and the Far East. The opening session will be in University College and the closing session at Guildhall, where members will be entertained to luncheon in the crypt. Other sessions will be in the London School of Economics and Political Science, and there will be an afternoon reception by the Vice-Chancellor of the University in the Senate House. Among those who will take part in the conference are the Duchess of Atholl, Lord Cecil, Lord Allen of Hurtwood, Prof. Gilbert Murray, Mr. Kenneth Lindsay and Mr. H. G. Wells. The last-named is to speak at a public discussion on "The Teaching of History". In connexion with the conference, a schools' poster competition has been organized with the object of advertising the value of the League of Nations and the International Labour Organisation as a means of securing the improvement of social conditions and of human welfare through international action. Further particulars can be obtained from the L.N.U., 15 Grosvenor Crescent, S.W.1.

Announcements

THE Forestry Commissioners have appointed a committee, under the chairmanship of Lieut.-Colonel J. C. Wynne Finch, to advise them about the suitability of the Forest of Dean as a national forest park. Mr. Frank H. Harris and Mr. E. S. J. Hinds, Forestry Commission, 55 Whitehall, London, S.W.1, are joint secretaries to the Committee.

THE Linnean Society of London will celebrate the one hundred and fiftieth anniversary of its foundation on May 24–26. The president, Dr. J. Ramsbottom, will deliver an address on May 24 at 6 p.m., and on May 25 and 26 symposia on "The Concept of Species from the Time of Linnæus to the Present Day" will be held. Further information can be obtained from the Assistant Secretary, Linnean Society, Burlington House, Piccadilly, London, W.1.

Flying Officer A. E. Clouston and Mr. Victor Ricketts arrived at Croydon on March 26, having accomplished a return flight between England and New Zealand (about 24,000 miles) in 10 days 21 hours. This is the first time that a direct double flight has been made, and several new records were set up. The aeroplane was the de Havilland Comet which won the international air race from London to Melbourne in 1934.

PROF. CAMILLE GUTTON, of the Ecole Nationale supérieure de l'Aéronautique and the Ecole professionnelle supérieure des Postes et Télégraphes, Paris, has been elected a free academician of the Paris Academy of Sciences, in succession to the late Paul Janet.

THE first International Congress of Cosmobiology, organized by the Société médicale de Climatologie et d'Hygiène du Littoral Méditerranéen, will be held on the Côte d'Azur on June 2–8. Prof. D'Arsonval will preside over the radiological section and M. Lumière over the biological section. Further information can be obtained from the secretary, 24 rue Verdi, Nice.

THE following have recently been nominated members of the Imperial Leopold Caroline German Academy at Halle: Dr. Matsujiro Takenouchi, professor of bacteriology at Tokyo, Dr. Antonio Dias Albertini, president of the Finlay Institute at Havana, Dr. Sven Petrus Ekman, professor of zoology at Uppsala, Dr. Mokoto Ishiwara, professor of physiology at Fukuoka, Japan, Dr. Gustav Senn, professor of botany at Basle, and Dr. S. P. L. Sørensen, head of the Carlsberg Institute at Copenhagen.

REPRINTS of fourteen papers by Mr. T. S. Subbaraya, Central College, Bangalore (University of Mysore), and his collaborators, published between 1929 and 1937, have been received. Particular acknowledgment is made of indebtedness for the help and collaboration of Prof. B. Venkatesachar, professor of physics in the University. The scope of the papers is too wide to permit of description in a short paragraph. The topics divide themselves almost completely into two classes, one dealing with nuclear structure and nuclear magnetic moments, and the other with problems in spectroscopy. In the latter category is a series of important papers on the spectrum of ionized mercury. There are papers dealing with the spectrum of ionized zinc, and with the band spectra of cadmium, zinc, cadmium iodide, and mercurous iodide. An early paper discusses the range of distinct vision of the unaided eye under water.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 610.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Aerial Drift of Insects

SINCE the summer of 1932 the distribution of insects by aerial currents has been studied in this Department. The present communication concerns the experiments made with kites over the land; investigations over the sea were briefly reported last year[1]. The methods employed have been borrowed from oceanography and inverted. Tow-nets, with a three-foot diameter mouth, have been carried into the air by kites to heights ranging from 150 ft. to 2,350 ft. The nets were sent up closed, opened automatically at the desired height, and closed again at the end of the sampling period before being hauled down. 82 samples were obtained, yielding 839 insects in a total collecting time of 124½ hours from May until September.

Fig. 1 shows the average density of the aerial population based on more than 10 hours collecting in each of the height ranges: 150–300 ft., 300–500 ft., 500–750 ft., 750–1,000 ft. and 1,000–2,000 ft. The curve represents the average number of insects taken per 10 hours collecting with our standard 3-foot diameter net in each height range and the scale of dots represents the average number of insects at each height drifting over a 10 *yards frontage* in an hour; each dot represents a hundred insects. It shows clearly the aerial food available for swifts and swallows. Incorporated in the curve are values

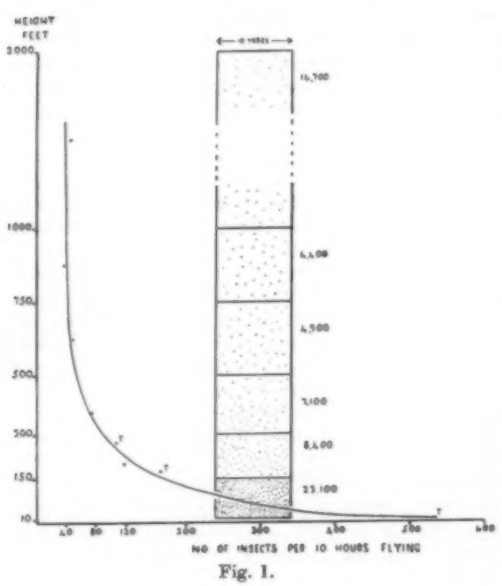


Fig. 1.

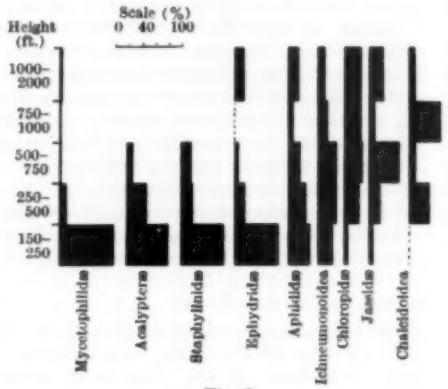


Fig. 2.

(*T*) obtained from an intensive study of the insect drift at lower levels made by Mr. J. A. Freeman using nets flown simultaneously at heights of 10 ft., 177 ft. and 277 ft. on each of three masts over a 5/6 mile frontage at the Beam Wireless Station at Tetney, Lincolnshire.

The 'aerial plankton' is made up essentially of small light-bodied insects with weak powers of flight, but with a relatively large wing surface compared with body mass. Fig. 2 shows the comparative vertical distribution of the nine more important families encountered between 150 feet and 2,000 feet; the average number of any one family per 10 hours collecting in each height range is shown as a percentage of the total of that family taken (per 10 hours collecting) at all height ranges. Nearly all the families recorded in the aeroplane collections of Collins and Baker[2] in America and Berland[3] in France have been taken in our kite nets.

Whilst different insect groups are shown to be influenced somewhat differently by atmospheric conditions, it is found for all that high temperature and low humidity are more favourable to aerial drift than the reverse conditions.

Among agricultural pests, the frit fly, *Oscinis frit* Linn., was taken on many occasions up to 600 feet, thrips up to 450 feet and aphides, including the grain aphis *Macrosiphum granarium* Kby., up to 1,600 feet. That so many insects have been taken over the sea when more than a hundred miles from land[1] emphasises the importance of wind drift in the dispersal of insect pests both from one part of the country to another as well as the infection of Great Britain from the continent. Whilst migrating birds may well be the carriers of foot-and-mouth disease, the possibility of insects also being the carriers should not be overlooked.

With the kind co-operation of the London and North Eastern Railway a study of the varying abundance of insects along a line of country was begun last summer by using collecting nets on railway trains between York and Hull. By changing the nets at definite points along the line and repeating the lines of observation throughout the summer, the variations in population densities have been studied in relation to meteorological data. Marked distributional changes are observed over quite short periods of time. It is hoped that the experiments may be extended over a wider area in the future.

A first full report will be published in the *Journal of Animal Ecology*.

A. C. HARDY.
P. S. MILNE.

Department of Zoology
and Oceanography,
University College,
Hull.
Feb. 21.

[1] NATURE, **139**, 510 (1937).
[2] *J. Econ. Ent.*, **27**, 320–327 (1934).
[3] *Ann. Soc. Ent. France*, **104**, 73–96 (1935).

Distorted Mountain Strata in Relation to Final Isostasy

ISOSTATIC equilibrium ensues only after disturbances have ceased. The strata of mountains must originally have been deposited horizontally. They may be held to have attained to heights much greater than now exist. As they accumulated locally gravity would be disturbed by their weight, and if they rested on a much deeper foundation of slightly viscous but more dense material they would gradually sink down into it until they floated in hydrostatic equilibrium. It is assumed that this sinking is a slower process than the deposition of the strata. As the result, if a level datum surface is imagined as traced in the viscous foundation, at a level below the sunk roots of the deposited strata, hydrostatic equilibrium along it requires that the weight of material in all columns standing on this surface should be uniform. This is the observed isostasy; thus, beneath a more elevated region its roots of lighter density would penetrate deeper and so compensate the extra column aloft. The depths of these floating roots should even exceed the heights of the elevations, so the height of the original deposited strata would have been much greater than that of the present compensated mountains. In the deep sinking of such horizontal local strata they would be broken up, with result reminiscent of the distorted fragmentary mountain strata that are observed. But an analogy to the breaking up of an Arctic ice-floe would be excessive.

This order of ideas may doubtless be entertained with reluctance, but it appears to offer the only path by which the actual recognized degree of isostasy can have been arrived at. For the case of a linear mountain range the sinking of the strata would be smoother on the two sides of the central axis. It may be that the main part of the mass has been pushed up from below, but it has still to fall back into isostasy, which any sedimental part clinging to it will show by warping.

After an inconclusive survey by Bouguer in the Andes, the earliest effective exploration in that direction was by Maskelyne and Cavendish on the wedge-shaped isolated mountain Schiehallien in Scotland, made with a view to estimating the mean density of the earth from the deviation of the plumb-line by the horizontal attraction of this mountain mass of perhaps roughly ascertainable density. If the mountain rests on floating roots less dense than the average the horizontal attraction would thereby be diminished, so that the apparent result for the earth's mean density would be increased from the true value: but actually the result was considerably less. Formal isostatic discussion was initiated from the early surveys of the corps of Royal Engineers in the Himalayas as analysed by Archdeacon Pratt of Calcutta. They revealed defects of density beneath the mountains. The principle of compensation was more recently extended as a working hypothesis to the whole earth, mainly by Hayford in America. It is now submitted that the undoubted facts of isostasy may provide the clue, however unexpected, to the inner mystery of mountain structure, so that only the later stages of mountain carving are due to atmospheric denudation.

JOSEPH LARMOR.

Holywood,
N. Ireland.
March 5.

Coenzyme of the *d*-Amino-acid Oxidase

IT has been shown by Das[1] that the soluble amino-acid oxidase of Krebs[2] requires for its activity the co-operation of a thermostable factor or coenzyme which can be obtained from animal tissues and from yeast.

The object of this investigation was to determine the nature of this factor. This could only be achieved after separation of the enzyme system into its two components: the thermolabile enzyme and thermostable coenzyme, followed by their purification. While this work was in progress, Warburg and Christian[3] announced in a preliminary note that they have succeeded in separating this enzyme system into its two components, and in purifying the coenzyme. They have not, however, revealed their method of preparation and purification of these components.

I propose to give here the main results of my work on amino-acid oxidase, together with a description of the methods used in the preparation and purification of the enzyme and coenzyme.

Preparation of Enzyme. Finely powdered acetone-dried pig's kidney is extracted with 20 vol. water and the insoluble residue centrifuged off. To each 100 c.c. solution is added 1 gm. tricalcium phosphate gel, which is centrifuged off together with adsorbed inactive protein. To every 100 c.c. of this solution is added 22 gm. ammonium sulphate, and the mixture left standing 12 hours at room temperature. The precipitate is dissolved, reprecipitated in the same way, redissolved in water, dialysed and centrifuged. The solution is adjusted to *p*H 6·5, the enzyme is adsorbed on alumina gel (*A*) and eluted with phosphate buffer *p*H 7·8, giving an almost colourless solution of enzyme, inactive in absence of coenzyme but highly active (Q_{O_2} = 1,000) in its presence, and oxidizing the unnatural isomers of alanine and proline.

Preparation of Coenzyme. Horse heart muscle is minced and washed twice in 10 vol. tap water. 1 kgm. of washed mince is extracted with a mixture of 850 c.c. acetone and 150 distilled water at 50° C.

The warm mixture is pressed through muslin, cooled, filtered with kieselguhr, treated with 0·5 c.c. concentrated ammonia and concentrated to 20 c.c. The solution is then treated with 50 c.c. acetone and 0·5 c.c. acetic acid. The precipitate is removed and the solution mixed with 200 c.c. acetone. The precipitate, which contains the coenzyme, is dissolved in 5 c.c. water, centrifuged, and the clear solution treated with 50 mgm. barium acetate and 10 c.c. ethyl alcohol. The precipitate is collected, decomposed with 2–3 c.c. dilute sulphuric acid, the barium sulphate centrifuged off and the coenzyme solution precipitated by 10–15 volumes acetone.

This yellow powder which contains the coenzyme is readily soluble in water, but insoluble in organic solvents. It is precipitated by salts of mercury, lead and barium, but not by calcium, even in the presence of 2 vol. alcohol. It is very unstable in acid solution but not affected by weak alkali. A slightly alkaline solution of coenzyme has a characteristic yellow colour with the greenish fluorescence of flavines and a spectrum similar to that of lactoflavine. The colour disappears on reduction with $Na_2S_2O_4$ and reappears on shaking the solution with air.

2·5 kgm. heart muscle yields about 12 mgm. of very active coenzyme containing about 20 per cent flavine.

The activity of the reconstructed system tested aerobically in Barcroft differential manometers is shown in the following table:

OXYGEN ABSORPTION IN AIR AT 39°.

	1	2	3	4
Enzyme solution	1·0	1·0	1·0	1·0
M/10 phosphate buffer *p*H 7·8	2·0	2·0	2·0	0·2
3·3 per cent *d*,*l*-alanine solution	0·3	0·3	0·3	0·3
Coenzyme, added in buffer sol.	—	1·5γ	3·0γ	6·0γ
c.mm. oxygen absorbed in 10 min.	1·0	34·5	63	105
c.mm. oxygen absorbed in 20 min.	2·8	69·0	124	207

While in presence of enzyme and substrate only, methylene blue (0·5 c.c.; 1 : 5,000) is not reduced anaerobically even in 12 hours; on addition of coenzyme (10 γ) it becomes reduced in about 27 minutes.

The fact that the flavine content of coenzyme preparations was proportional to their activity supports the view that the flavine is a part of the active compound. It is conceivable that the coenzyme is related to a compound containing 40 per cent flavine isolated by Theorell, Karrer, *et al.*[4] from animal tissue, a compound which has different properties from phosphoric esters of flavine obtained synthetically or isolated from yeast.

The ubiquitous presence of the coenzyme described in tissues, where no deamination is observed, suggests that it can also play an important part in other oxidation reactions of the cell.

F. B. STRAUB.

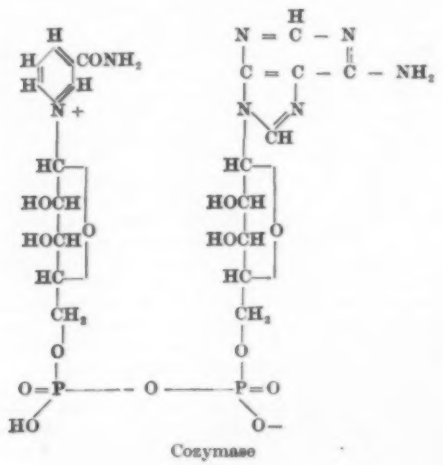
Molteno Institute,
University of Cambridge.
Feb. 22.

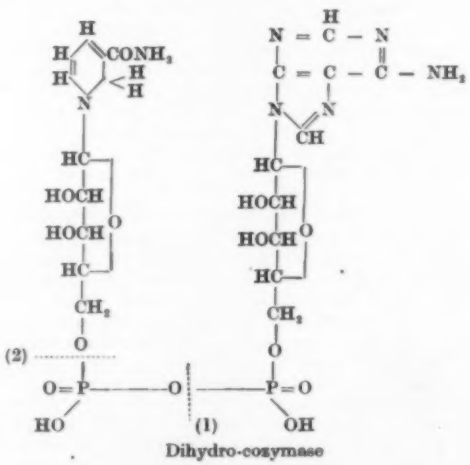
[1] Das, N. B., *Biochem. J.*, **30**, 1080, 1617 (1936).
[2] Krebs, H. A., *Z. physiol. Chem.*, **217**, 191 (1933).
[3] Warburg, O., and Christian, W., *Biochem. Z.*, **295**, 261 (1938).
[4] Theorell, H., Karrer, P., Schöpp, K., and Frei, P., *Helv. chim. Acta*, **18**, 1022 (1935); Karrer, P., Frei, P., and Meerwein, H., *Helv. chim. Acta*, **20**, 79 (1937).

Enzymic Dephosphorylation of Cozymase

FOLLOWING the observations[1,2,3] that cozymase is inactivated by vegetable as well as animal tissues it was considered to be of interest to study the mechanism of inactivation. Euler, Adler, Günther and Hellström[4] found that cozymase was inactivated by dialysed muscle extract, but that the latter was active in glycolysis only when cozymase and adenylic acid were added. They concluded that no adenylic acid was formed and suggested that the inactivation of cozymase might possibly be due to dephosphorylation. The present investigation shows that cozymase is rather slowly dephosphorylated by nucleotidase which dephosphorylates adenylic acid and inosinic acid much more rapidly (the former more easily than the latter). On the other hand, dihydro-cozymase is dephosphorylated about twice as fast as cozymase. In animal tissues cozymase is present in the oxidized as well as in the reduced form, and the present observation might suggest some biological indications.

According to Euler and Schlenk, the cozymase molecule is as follows:





Considering the biological functions and structure of cozymase as well as dihydro-cozymase, it might be suggested that dihydro-cozymase is capable of being split enzymatically[4] at position (1) to adenine nucleotide and nicotine nucleotide and that the enzyme nucleotidase dephosphorylates the mononucleotides. Alternatively it might also be suggested that dihydro-cozymase is split at position (2) forming adenosin-diphosphoric acid, which is dephosphorylated by adenylpyrophosphatase present in the enzyme preparation. In either of these cases it seems probable that dephosphorylation of dihydro-cozymase, on account of its dibasic character, is facilitated more than dephosphorylation of monobasic cozymase.

No definite statement can be made as to the implications of the present observation until further investigations have been carried out.

Nucleotidase was prepared from intestinal mucosa according to Klein[6] and was purified by isoelectric precipitation at *p*H 4·7. The precipitate was dissolved in alkaline water and dialysed overnight.

Cozymase free from adenylic acid was reduced with sodium hydrosulphite at *p*H 7·2–7·4, and the excess of hydrosulphite was removed by aeration. The resulting dihydro-cozymase was carefully maintained at *p*H 7·6–8·0. The amount of dihydro-cozymase was estimated spectrophotometrically.

The experiments were carried out *in vacuo*, the substrate being added after evacuation in order to prevent re-oxidation of dihydro-cozymase and the reaction was stopped by 4 per cent CCl_3COOH without letting air enter the reaction mixture before it was acidified. Veronal buffer at *p*H 7·6 has always been used in the reaction mixture. It has been found that the dephosphorylation of dihydro-cozymase was not due to sulphate present. The parallel experiments with cozymase and dihydro-cozymase were done with the same cozymase preparation under identical conditions. Under the same experimental conditions, dephosphorylation of adenylic acid is about four times as large as that of oxidized cozymase.

The following table shows typical results:

Reaction time. (min.)	Purity of cozymase per cent	γ P/mgm. cozymase	γ P/mgm. dihydro-cozymase
30	100	18·75	34·0
30	100	31·25	50·0
15	90	16·12	35·64
15	90	17·12	26·14
30	90	25·75	44·68

N. B. DAS.
H. v. EULER.

Biochemical Institute,
University of Stockholm.
Feb. 26.

[1] Euler and Myrbäck, *Hoppe-Seylers Z.*, 177 (1928).
[2] Euler and Günther, *Hoppe-Seylers Z.*, **243**, 1 (1936).
[3] Euler and Heiwinkel, *Naturwiss.*, **25**, 269 (1937).
[4] Euler, Adler, Günther and Hellström, *Hoppe-Seylers Z.*, **245**, 217 (1937).
[5] Euler and Adler, *Hoppe-Seylers Z.*, **252**, 41 (1938).
[6] Klein, W., *Hoppe-Seylers Z.*, **207**, 125 (1932).

Standardization of Gonad-stimulating Hormones

IN view of a recent publication by Hamburger and Pedersen-Bjergaard[1] relating to methods of standardization of the gonad-stimulating hormones, the following observations made in these laboratories may be of interest.

I am in complete agreement with Hamburger and Pedersen-Bjergaard's contention that the corpus luteum method in mice and the vaginal smear method in rats are the most accurate available for standardization of the urinary gonad-stimulating hormone (Gonan, Physex, etc.). Formerly, it seemed to me more logical to use the corpus luteum method[2], since I was engaged on problems in which this phase of activity of the hormone was of particular interest. With the widening of the scope for such preparations to include even treatment of male gonadal dysfunction this argument disappears. I now standardize Gonan in terms of its ability to produce œstrus in 50 per cent of immature rats (40–50 gm. in groups of not less than ten), when given over a period of 2½ days. Smearing is begun 1½–2 days after the last injection, if the vagina is open. The ratio of this rat unit to the mouse unit (luteinizing) has been found to be about 1 : 12; this compares with a 1 : 15 ratio found by the Danish workers.

With regard to standardization of the hormone of pregnant mares' serum (Serogan, Antex), I am not in such complete agreement with these workers. In the first place, it is interesting to note that they consider the rat a more suitable animal than the mouse when the criterion of activity is increase of ovarian weight. They give the average weight of a pair of infantile mouse ovaries as 2·2 mgm.; in these laboratories I find a figure of 1·7 mgm. for our stock and, although I work with minimum groups of ten, I feel that dissection cannot be carried out with sufficient accuracy with organs of this size, and I invariably prefer to work with rats when adopting this criterion of activity.

It is, however, generally recognized that the gonad-stimulating hormone of the serum of pregnant mares is predominantly follicle-stimulating (or œstrus-producing), and it seems to me that the vaginal smear technique is therefore a logical one to use, apart from its (in my opinion) greater accuracy. With a view to the use of this method, I have therefore carried out a series of tests to determine the ratio of the mouse unit, that is, the amount required to double the weight of the ovaries in 4 days, to the rat unit, the definition of which is the same as described above in dealing with the gonad-stimulating hormone of human pregnancy urine. Groups of ten rats were used, and 1 rat unit was found to be about 1/10 mgm., the ratio R.U. : M.U. (as described above) being 1 : 2.

Finally, it will be observed that throughout this communication I have avoided using the term 'gonadotropic', which has been in common use for a considerable time. A recent letter from Dr. Parkes[3] has stimulated interest in the question of nomenclature, but I do not feel entirely satisfied with the suggestions made by him. I therefore prefer to adopt a system used for some years particularly by the American workers in this field, that is, to refer to the 'gonad-stimulating' hormones, until some general international agreement can be reached.

P. G. MARSHALL.

Biochemical Laboratories,
British Drug Houses, Ltd.,
Graham Street, N.1.
Feb. 18.

[1] Hamburger and Pedersen-Bjergaard, *Quart. J. Pharm.*, **10**, 662 (1937).
[2] Marshall, *Biochem. J.*, **27**, 626 (1933).
[3] Parkes, NATURE, **141**, 36 (1938).

Failure of Anaphase Separation in Species Hybrids

IN the meiosis of species hybrids we are accustomed to finding abnormalities which are due to structural differences, abnormalities such as failure of pairing of chromosomes. There are also instances in which the genotypic upset in the hybrid gives rise to an abnormal course of meiosis, usually likewise causing a failure of pairing, for example, *Drosophila pseudo-obscura*[1]. In a cross between two grasshopper species, *Chorthippus bicolor* Charp. and *Ch. biguttulus* L., which I have succeeded in obtaining experimentally as well as in Nature, I have found an example of genotypic abnormality which shows itself acutely for the first time during the anaphase separation of the normally paired chromosomes.

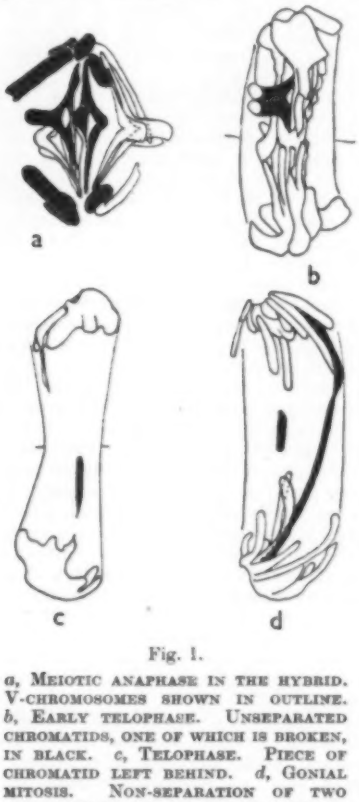


Fig. 1.

a, MEIOTIC ANAPHASE IN THE HYBRID. V-CHROMOSOMES SHOWN IN OUTLINE. *b*, EARLY TELOPHASE. UNSEPARATED CHROMATIDS, ONE OF WHICH IS BROKEN, IN BLACK. *c*, TELOPHASE. PIECE OF CHROMATID LEFT BEHIND. *d*, GONIAL MITOSIS. NON-SEPARATION OF TWO CHROMATIDS AND PIECE OF ANOTHER CHROMOSOME LEFT BEHIND.

The chromosomes of *Ch. bicolor* have been described by Darlington[2] and those of *Ch. biguttulus* do not differ appreciably from them. In meiotic metaphase the bivalents are of the more contracted type found among the grasshoppers. But in the hybrid they are long and slender throughout, rendering the analysis of chiasmata very simple indeed. They are like the chromosomes of *Mecostethus*[3] and *Chrysochraon*[4], save for the variable arrangement of chiasmata which resembles that in the parent species. Owing to their slenderness, however, irregularities in the metaphase movements occur, showing that repulsions between the centromeres fail to be effective in causing movement when they are exceptionally far apart.

With this exception the beginning of anaphase is normal, but the further it proceeds the more obvious does it become that normal separation is being hampered (Fig. 1*a*). The parts between the centromeres and the nearest chiasma are often drawn out and not infrequently break. The chromatids beyond this chiasma, which should separate, stick to each other instead. In some cells they seem to yield eventually to the stress exerted by the spindle and separate. But very often they break (Fig. 1*b* and *c*), the pieces being included in the daughter cells or left behind. In a great many cases a single restitution nucleus is formed. The second division is still more irregular. Spermatid nuclei therefore vary in size and are often polyploid. In spite of all this a good deal of seemingly normal sperms are seen, but whether they are functional is not yet known.

During the examination of the hybrid cells the following explanation has suggested itself. In metaphase the chromatids are closely associated, nay optically indistinguishable in most cases. There is a specific attraction between them. This attraction is a condition for the tension between centromeres so often seen in metaphase of meiosis in bivalents with chiasmata close to the centromeres. As pointed out by Darlington[5], a necessary condition of anaphase separation is the lapsing of the specific attraction. That the chromatids become free by an autonomous lapse of attraction rather than by the pulling force of the centromere movement is evident from the observation that the chromatids (particularly of long chromosomes) in anaphase often let loose one another's distal parts without stretching of the already free proximal parts. It is true that on the other hand the chromatids not infrequently appear to be actively separated by the pull of the centromeres. But if we assume that the lapse of attraction between the chromatids begins at the centromere and proceeds towards the ends at a rate that normally varies from one adjusted so as to keep pace with the centromere movement to a somewhat greater rate, such a variation in the appearance of the anaphase separation would be expected. All this, I think, holds good for mitosis as well as for meiosis, although perhaps often not so easily tested in the former case.

Assuming now that in certain circumstances the lapsing process is proceeding too slowly in relation to the centromere movement, or in other words that the distal parts remain in metaphase condition too long, the observed anaphase disturbances would appear. The bringing together in the hybrid of two different genotypes has, on this view, caused such an alteration of the synchronization of the anaphase events. That this may also happen in mitosis is shown by cases as in Fig. 1*d* and by the occurrence of incompletely separated meiotic prophase nuclei. It is obvious that in these hybrids the timing unbalance which shows itself in anaphase is correlated with the reduced or semi-mitotic contraction, both falling in the wide class of phenomena brought under a single aspect by Darlington's precocity theory.

It is interesting to note that occasionally a failure of the ends of chromosomes to separate has been observed in the parental species also. The process of anaphase is naturally affected by environmental variations like all genotypically controlled properties.

The behaviour of chromosomes in the meiosis of the hybrid is strikingly similar to that found by White[6] in *Mecostethus* 7½ hours after X-ray treatment. In fact, his figures correspond exactly with

those published here. Sax[7] has recently given an account of the varying agents (X-rays, temperature changes, chemicals, genes, ageing, etc.) which are known to affect nuclear division after division of the chromosomes. He points out that in most cases the irregularities seem to be similar and appear to be effected by disturbing the synchronization of nuclear and cytoplasmic activities. This disturbance may in some cases at least be of the kind inferred above.

To what extent permanent structural changes can be attributed to breakage in hampered anaphases remains yet to be studied.

HOLGER KLINGSTEDT.

John Innes Horticultural Institution,
Merton, S.W.19. Feb. 14.

[1] Dobzhansky, *Z. Zellf. u. mikr. An.*, **21**, 169 (1934).
[2] Darlington, *J. Gen.*, **33**, 465 (1936).
[3] Janssens, *La Cellule*, **37** (1924).
[4] Klingstedt, *Mem. Soc. pro Fauna et Flora Fennica*, **12**, 194 (1937).
[5] Darlington, *Proc. Roy. Soc.*, B, **121**, 281 (1936).
[6] White, *Proc. Roy. Soc.*, B, **124**, 183 (1937).
[7] Sax, *Amer. J. Bot.*, **24**, 218 (1937).

Double Structure of Chromosomes

IN response to our demonstration[1] that the metaphase chromosomes of *Trillium* are composed of four strands twisted about each other in pairs, while the anaphase chromosomes contain two intertwined threads, Dr. Darlington[2] states that the appearance of two threads is an artefact induced by a fixative containing acetic acid, and due to "bubbles" arising in the chromatid. In confirmation of this, he publishes a photomicrograph of a cell in telophase which bears little resemblance to our figures.

The preparations photographed in our letter were fixed in strong Flemming, which contains acetic, but other preparations made at the same time and fixed in Benda without acetic, following treatment with vapour of ammonia, hydrochloric or nitric acid, gave the same result. This disposes of Dr. Darlington's argument that the double threads are due to the treatment, even if it were not untenable on other grounds. His "bubble" theory is a revival, under another name, of the conception which was current in 1911, and earlier, that anaphase and telophase chromosomes developed alveoli or vacuoles in passing into the resting condition. Also, according to definition, bubbles are composed of gas or vapour in a liquid medium, so that the use of the word is incorrect.

Dr. Darlington's question regarding the possibility of three threads in metaphase chromosomes is misleading, because a photograph in one plane of two intertwined threads twisted around two other intertwined threads will give, in places, a superficial appearance of alveoli side by side. But a photograph at this magnification cannot be taken in three dimensions.

Dr. Darlington has introduced the subject of chromomeres which has been dealt with in a paper now in course of publication. Suffice it to say that all recent critical observations on plant chromosomes show a continuous chromonema and not a discontinuous row of chromomeres.

Finally, it may be pointed out that the photomicrographs published in our previous letter[1], showing the doubleness of the chromosomes in *Trillium sessile*, were only the final proof concluding a long line of increasingly cogent evidence. That evidence is contained in innumerable papers from many laboratories, some of them so early as 1926, including a series of papers from this laboratory beginning in 1931. Dr. Darlington and his supporters face this mass of evidence with the assertion that the chromosomes must be single in anaphase and telophase because some of the X-ray experiments can be interpreted in this sense. White's work[3] on the X-irradiation of the first meiotic division in three species of insects casts doubt on this interpretation.

R. R. GATES.
S. V. MENSINKAI.

King's College,
London. March 9.

[1] NATURE, **140**, 1013 (1937).
[2] NATURE, **141**, 371 (1938).
[3] White, M. J. D., *Proc. Roy. Soc.*, B, **124**, 183–196 (1937).

Effect on Organisms of Summer Drought in Caves

AMONG the most interesting of cavicolous invertebrates from Herzegowina is the Serpulid, *Marifugia cavatica* Abs. and Hrabě[1]. This remarkable worm, although belonging to a typical marine group, forms its calcareous tubes in great quantities over the walls and ceiling of the inland limestone cave known as Crnulja, in Popovopolje. The worm itself is known from this and a few neighbouring caves only; deserted tubes or their debris are more widely distributed, and may point to the existence of the worm in uninvestigated recesses of caves as far north as Istria. While visiting Popovopolje in August 1937 I found debris of the tubes in the much-explored Vjetrenica pećina, where Remy[2] has stated that it does not occur. I brought back some of the living worms from Crnulja to England, and am indebted to Mr. C. C. A. Monro for confirmation of the species.

During the winter the worms are immersed in fresh water; for the rest of the year they live retracted within their tubes, covered by only a thin film of water of condensation. The conditions then are so dry that Remy records the desiccation of a Plumatellid and its formation of statoblasts. In this connexion, I would record finding among the tubes of my *Marifugia* quantities of sponge gemmules, which have been identified by Dr. M. Burton as those of *Ephydatia mülleri* Lieberkühn. Above ground the gemmules of related Spongillidæ are stimulated to germinate by increase in temperature and give rise to young sponges in the spring. But, in the cave, conditions are reversed; the gemmules occur in summer and must give sponges in winter, the only time when the cave is flooded and sufficient water is available for active sponge life.

On returning to England, I made germination experiments with the cave gemmules, using gemmules of epigean *Spongilla lacustris* as a control. Of the latter, 50 per cent germinated in 10 days, and gave good sponges, with oscula and flagellated chambers. Of the cave species, however, only 2 per cent germinated in a period of 22 days; and the development here was quite abortive, neither oscula nor flagellated chambers appearing, although the germinating sponge material lived long enough and was extensive enough to have thus differentiated. It would seem, then, that in respect of gemmule germination, this cavicolous strain of *E. mülleri* reacts quite differently from the epigean *E. fluviatilis* L., which, according to Brien[3], behaves similarly to the control, *Spongilla lacustris*.

R. S. HAWES.

Zoology Department,
King's College,
University of London.
Feb. 21.

[1] Absolon, K., and Hrabě, S., *Zool. Anz.*, **88**, 249 (1930).
[2] Remy, P., *Bull. Mus. Hist. Nat., Paris*, **9**, No. 1, 66 (1937).
[3] Brien, P., *Arch. Zool. exp. gen.*, **74**, 461 (1932).

Stomatal Movement and Epidermal Water-Content

PROF. D. THODAY has suggested[1] that the remarkable stomatal behaviour of coffee may be explicable on a hypothesis involving variations in the water content of the epidermis as distinct from that of the leaf as a whole. As he says, a critical experiment would be the determination, in saturated air, of the relation between stomatal aperture and radiation. This has not been done.

However, the climatic range over which coffee is grown is wide: and I have determined its stomatal behaviour in semi-arid, cloudless, windy, unshaded and exposed conditions, and in moist, cloudy, shaded and almost wind free habitats. In the former, the relative humidity is very low, and the evaporating power of the air is consequently high. In the latter, the reverse is true, and relative humidity may remain very high throughout the day. Yet the relation between stomatal behaviour and incident radiation is similar in both habitats, and the stomata always close in strong light.

A sunfleck, illuminating one leaf on a coffee tree under dense shade and in a nearly saturated atmosphere, will cause rapid stomatal closure in that leaf, although physical evaporation and hence cuticular transpiration must be minimal.

It seems, therefore, unlikely that the peculiar stomatal behaviour of coffee, under these varied conditions, can be explained on the lines suggested.

F. J. NUTMAN.

East African Agricultural Research Station,
Amani,
Tanganyika Territory.

[1] NATURE, 141, 164 (1938).

IN view of the information given by Mr. Nutman, I agree that my suggestion can scarcely apply. Mr. Nutman's observations appear to add a new type of response to the possible complexities of stomatal behaviour and make it still more evident that specific differences have to be considered.

D. THODAY.

Penetration of Ultra-Violet Rays through Chitin

ALTENBURG in 1928 found that the fluorescence of certain salts was only very slightly, if at all, affected when *Drosophila melanogaster* were interposed between the discharge tube of a Cooper Hewitt lamp and the salts at which the rays were directed. From this he concluded that the ultra-violet rays penetrated the chitin rather freely. His conclusion has been accepted by subsequent workers. Altenburg did not state, however, which salts were used, how many layers of flies there were, or how closely they were arranged. Besides, the shortest wave-lengths of visible light also cause fluorescence of salts.

In order to obtain more definite data, we planned experiments, using a Hanovia quartz mercury vapour lamp, to determine the limit of thickness of chitin that can still be penetrated effectively by the ultra-violet rays produced by this lamp. It was found that 60 minutes irradiation through a vitreosil plate 0·5 cm. in thickness had a striking effect on the wing development of rather aged pupæ. The distance was maintained at 11 inches. Of the imagines which emerged, approximately 60 per cent showed distinct wing modifications of great variety. Undoubtedly the hypodermal cells between the two chitinous layers of the immature wings were effected by these rays which must, therefore, have penetrated effectively through the chitin of the puparium and of the pupal wing. The control flies were treated in the same manner but the dishes, instead of being covered by a vitreosil plate, were covered by ordinary glass of the same thickness.

The control material showed no effect even after several hours of irradiation, while a dosage of more than 80 minutes proved very deleterious to the experimental material. A uniform dosage of 60 minutes irradiation was maintained for all pupæ treated in these experiments. Besides the wing abnormalities observed, the viability of the experimental material, that is, the pupæ covered by vitreosil plate, was reduced by about 30 per cent as compared with the controls

This positive effect of the ultra-violet rays on the wing development suggested a means of testing out the effective penetrability of chitin to ultra-violet rays. For this purpose the flying wings of the locust *Nomadacris septemfasciata* were used in preparing small screens 2 in. × 2 in. Sections of wings of this locust species showed that the thickness of the wing ranges from 4μ to 10μ. The wings were carefully pasted on to frames of fairly thick paper, care having been taken to keep the window portion clean of paste. In this manner screens of 1-, 2-, 3- and 4-wing thickness respectively were made, and irradiation experiments carried out as stated above.

A spectrographic analysis was then made of the wave-lengths which penetrated the prepared chitin screens distinctly. The results are shown in the following table:

Screen	Absorption in A.	Percentage wing abnormalities
0·5 cm. window glass ..	<3650	0
4 wings vitreosil	<3650	0
3 wings "	<3650	0
2 wings "	<3125	40
1 wing "	<2967	54
vitreosil	<2534 } (?) <2398 }	60
quartz lens	<2225	62

The spectrum was mapped from 1900 A. to 4400 A. No lines were found below 2224·7 A. The range of the instrument is just outside the very intense mercury line 1849·6 A. As the absorption increases both with the increased thickness of the filters and with the decrease in wave-length, it is reasonable to suppose that light of wave-length 1849·6 A. will behave similarly to longer wave-lengths.

As a photo-densitometer was not available, quantitative expressions of absorption were not possible. It is hoped to rectify this in future experiments.

From these results it appears that our dosage was ineffective when the chitin layer was 3 wings (about 21 μ) thick or thicker; the wave-length 3125 A. was still biologically effective, but 3650 A. and longer wave-lengths were not.

We wish to thank Prof. G. H. Stanley, director of the Minerals Research Laboratory for the use of apparatus and Mr. L. W. Vermeulen for technical assistance.

G. ELOFF.

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and
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University of the Witwatersrand,
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Feb. 22.

V. L. BOSAZZA.

An Effect of X-Radiation on the ξ Potential of Colloidal Graphite

IN their recent communication on the above subject[1], Prof. J. A. Crowther and H. Liebmann have discussed results obtained with graphite sols containing only a little ammonia.

A later paper[2] describes an effect, which, if genuine, must be of importance in connexion with the biological effects of X-radiation. They find that on adding a "small quantity of surface-active material" to a sol of the above type, the sensitivity of the sol to X-rays is completely destroyed.

If this is the case, it is unlikely that the striking effect of X-rays upon the surface-charge of a colloid discovered by these authors can occur during the irradiation of cancerous animal tissue, since most living cells contain surface-active substances.

IAN KEMP.

70 Penns Lane,
Birmingham 24.
Feb. 25.

[1] NATURE, **140**, 28 (1937).
[2] Crowther, J. A., Liebmann, H., and Lane, T. B., *Phil. Mag.*, **24**, 654 (1937).

I AM very much aware of the fact that there is a very wide gulf between the simplicity of a graphite sol and the complexity of the intra-nuclear structures of living cells. If, from any unguarded expression in our paper, Mr. Kemp has been led to suppose that we imagined the gulf to have been crossed, he is wise to lodge a caveat. The curious effect of irradiation on the cataphoretic velocity observed by us in the case of colloidal graphite seems to be common to lyophobic sols, in general, and we have obtained it not only with amorphous carbon, both positive and negative, but also with gold, quartz, and ferric hydroxide.

The effect of irradiation on colloids of biological interest is now under investigation. Pending the results of these experiments, we should hesitate to draw general conclusions from the single observation to which Mr. Kemp directs attention, nor would we dogmatize as to possible applications to living cells. Too little is known about the chemistry of the cell and its nucleus. It is known, however, that biological changes are produced in the nucleus by doses of the order of magnitude which we are using in our experiments, and in view of the importance of the subject, any possible line of approach is worth exploring.

J. A. CROWTHER.

The University,
Reading.
March 5.

Structure of Heavy Elementary Particles

THE discovery of the heavy electron has recently led Bhabha[1] and Heitler to discuss in detail Yukawa's suggestion to account for nuclear forces by the assumption that a heavy particle is surrounded by a heavy electron of mass m during a fraction of time q.

It may be emphasized that this theory permits a very elementary treatment and allows us to obtain several consequences without extensive calculations. This is due to the fact that the emitted heavy electron, satisfying a wave equation of the type

$$\Box u - \varkappa_0^2 u = f(r) \cdot \delta(r) \exp\left(\frac{2\pi i}{h} W t\right), \quad \varkappa_0 = \frac{2\pi mc}{h}$$

is provided with an energy of the order of mass difference between proton and neutron, $W \sim \Delta M c^2 \sim 10^8$ ev. (Taking the recoil into account: $W \sim \frac{1}{2} mc^2 \frac{m}{M} \pm \Delta M$; $m \gg \sqrt{2M\Delta M}$.) It behaves outside the proton (or neutron) like a free particle in the limiting relativistic case $W \ll mc^2$; $u \sim \exp(-\varkappa r)/r$.

The theory meets with difficulties similar to those of electrodynamics, but it is not unlikely that the problem of light nuclei falls within its domain of applicability. If this is the case, we are led to the following conclusions:

(1) The theory gives for the degree of dissociation the value

$$q = \frac{1}{1 + \sqrt{1 - (W/mc^2)^2}} \sim \tfrac{1}{2},$$

which means that proton-proton forces are only slightly smaller than proton-neutron forces.

(2) The magneton of the dissociating heavy electron becomes

$$\mu = \frac{h}{2\pi} \cdot \frac{e\,c}{W},$$

of the order of one ordinary Bohr magneton. Thus, only a small percentage of the dissociation can be directed by the spin of the heavy particle.

A detailed account of these considerations will be given in the *Physical Review*.

GUIDO BECK.

Cité Universitaire,
Fondation Hellénique,
45 Boulevard Jourdan,
Paris (XIV).
March 1.

[1] NATURE, **141**, 118 (1938).

Methods of Estimating Mental Factors

IN a recent letter[1], Prof. G. H. Thomson has deduced an interesting relation between the equations which he and I have respectively proposed for estimating mental factors. It seems worth noting that this relation depends on a simple connexion between our estimates that previously I had not realized. Let the test scores for any one person depend on his or her group and specific factors, f_0 and f_1, according to the (vector) equation:

$$z = Mf = M_0 f_0 + M_1 f_1.$$

From the identity $K = J(1 - K)$, where $J \equiv M'_0 M_1^{-2} M_0$, $K \equiv M'_0 R^{-1} M_0$, $R \equiv MM' = M_0 M'_0 + M_1^2$, it is easy to establish the reversible relation between our respective estimates for f_0,

$$\hat{f}_0 = K\check{f}_0, \quad \check{f}_0 = K^{-1}\hat{f}_0.$$

Thus *as a (vector) statistic* one estimate is equivalent to the other. Their different interpretation and properties might conveniently be summarized here by the formulæ:

$$E\{\hat{f}_0\} = E\{f_0\} = 0, \; E\{(\hat{f}_0 - f_0)(\hat{f}_0 - f_0)'\} = 1 - K;$$

$$E_1\{\check{f}_0\} = f_0, \; E_1\{(f_0 - \check{f}_0)(f_0 - \check{f}_0)'\} = J^{-1} = K^{-1}(1 - K),$$

where E denotes averaging over all persons, E_1 over all possible sets of tests (comparable with the given set in regard to the amount of information on the group factors f_0).

To anticipate obvious criticism, it should be remembered that these formulæ are at present somewhat theoretical, owing to the necessity of *postulating* the initial equation $z = Mf$; but, as I have mentioned before, more empirical methods of statistical analysis are always available which may ultimately help to justify and establish such postulated equations.

M. S. BARTLETT.

100 Netherwood Road,
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Feb. 8.

[1] NATURE, **141**, 246 (Feb. 5, 1938).

"Foundations of Terrestrial Life"

IN the brief account in NATURE[1] (Dec. 25, 1937) of a lecture by Sir Frederick Keeble on "Foundations of Terrestrial Life: The Soil and the Green Plant", the conclusion to which he had come is stated thus: "This hypothesis is that the health and strength of people and their evolution, and the permanence of human societies depend on the soil and the green plant." This recognition of the fundamental importance of the green plant suggests a reference to another but very ancient résumé of science contained in the much-discussed first chapter of Genesis (verse 30). "And to every beast of the earth and to every fowl of the heavens and to every creeping-one upon the earth in which is the soul of life, I have given every greenness of herb for food." (President Harper's translation.) The customary translation is "every green herb"; but the Hebrew words are far more emphatic than the English translation; they read: "every greenness of green herb". The Hebrew word for "green herb" is one of the widest significance, and seems, according to Gesenius, to include every herb that has food value both for man and beast.

It is interesting to observe that the earliest and the latest pronouncements of science on this point are in perfect accord.

FRANK ALLEN.

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Jan. 31.

[1] NATURE, **140**, 1107 (1937).

Points from Foregoing Letters

A CURVE showing the average number of insects at various heights up to 2,000 ft., and diagrams indicating the comparative distribution of the nine more important families of insects, are submitted by Prof. A. C. Hardy and P. S. Milne. High temperature and low humidity were found to favour the aerial drift of insects. The insects were caught in nets 3 ft. in diameter, carried into the air by kites. The authors point out that wind-borne insects contribute not only to the spread of insect pests but also may possibly be carriers of foot-and-mouth disease.

Sir Joseph Larmor considers that if mountain ranges rest on a viscous foundation of *denser* material then, as the mountains accumulate locally, they would gradually sink down. The roots of the mountain would thus penetrate into the denser viscous material to an extent exceeding the height of the mountain, in order to compensate for the extra column aloft, very much like a submerged iceberg.

A description of the methods used in the preparation of the soluble amino-acid oxidizing enzyme of Krebs (from pig's kidney) and of its coenzyme (from horse-heart muscle) is given by Dr. F. B. Straub. The activity of the coenzyme is found to be proportional to its flavine content, and the author considers that flavine may be part of the active compound.

Nucleotidase (an enzyme which hydrolyses phosphoric esters) splits off the phosphate group from the molecule of cozymase (a coenzyme assisting the oxidation of carbohydrate), according to N. B. Das and Prof. H. v. Euler. The dephosphorylation takes place more slowly than in the case of the adenylic and inosinic acids. Dihydrocozymase also is dephosphorylated about twice as fast as cozymase, and this is attributed by the authors to the dibasic character of the former.

For the determination of the biological activity of urinary gonad-stimulating hormones (Gonan, Physex, etc.), P. G. Marshall prefers the vaginal-smear method in rats to the corpus luteum method in mice. Also in the case of the standardization of the hormone of pregnant mares' serum (Serogan, Antex) the author considers the vaginal-smear technique in rats preferable to the determination of the increase of ovary weight in mice, and gives the ratio of the mouse unit (amount necessary to double the weight of ovaries in four days) to the rat unit (amount needed to produce œstrus in 2½ days in 60 per cent of the immature rats).

In a grasshopper hybrid, studied by H. Klingstedt, owing to a failure in the separation of chromatids at anaphase, the chromatids often break or the separation of nuclei may be prevented. This abnormality is ascribed to a maintenance of metaphase attraction beyond its normal limit.

Prof. R. R. Gates and S. V. Mensinkai state that the double structure of chromosomes at metaphase was observed in preparations fixed with various reagents, and this excludes Dr. Darlington's objection, that the double-thread appearance is due to the treatment employed. The authors point out that much other evidence favours their view, and cast doubt on the X-ray experiments which have led Dr. Darlington to the opinion that chromosomes must be single in the anaphase and telophase stages.

R. S. Hawes describes the behaviour of the serpulid worm *Marifugia cavatica* in the inland limestone caves of Herzegowina which are flooded in winter and dry in summer. In the calcareous tubes of these worms he has found gemmules of the sponge *Ephydatia mülleri*. Only 2 per cent of these gemmules of the cave-dwelling species germinated under experimental conditions which were suitable for the development of the surface species *Spongilla lacustris* (which conditions had also been found to be suitable for the nearly related surface species *E. fluviatilis*).

Experiments carried out by Dr. G. Eloff and V. L. Bosazza show that chitin of approximately 0·02 mm. in thickness absorbed wave-lengths less than 3650 A. The biological effects are in keeping with the physical data. A Hanovia quartz mercury vapour lamp was used.

Research Items

Nayadis of Malabar

MR. A. AIYAPPAN, in introducing his study of the social and physical anthropology of the Nayadis, a beggar caste of Malabar (*Bull. Madras Govt. Museum, N.S. Gen. Sec.*, **2**, 4; 1937), points out that the centrifugal aspect of caste has diverted attention from the function of caste in the caste *milieu*. The Nayadis are the lowest known caste in India, polluting even the Pariah by their approach. When begging for alms in the stentorian voice, which is their most noticeable characteristic, they must stand yards away from the road. Their poverty and degradation constitute them a serious problem, which for long has engaged the attention of missionaries, administrators and social reformers. The origin of the Nayadis is obscure. A persistent tradition derives them from the Namputiri Brahmins, the highest grade in the Malabar social hierarchy, from which their forbears are said to have been ejected as 'unclean'. Sanctity is added to the repute of the caste by this tradition of origin. As beggars the Nayadis do not need to excite the compassion of the charitable as do those who have fallen on evil days. Their alms arise from the religious faith of the donors. They receive gifts on regular occasions—regular days of the week, and special occasions, such as the twelfth day of the waxing and the waning moon, and death-gifts. It is as much a sin to omit to give to them as to the Brahmins. Physically, the Nayadis stand midway between the hill jungle tribes and the castes of the plains; and in some there are distinctly Veddoid characteristics. The head is dolichocephalic and high. The estimated capacity shows that they belong to the microcephalic group. Their stature equals that of the lower castes, but is distinctly below that of the Namputiri Brahmins and Nayars. They are more platyrrhine than the lower castes, but less so than the Paniyans of the Wynad Hills.

The Zoology of Iceland

UNDER this title a work in five volumes is in preparation. A few parts are now published (Copenhagen and Reykjavik: Levin and Munksgaard, 1937) and include two by K. Stephensen: Marine Isopoda and Tanaidacea (vol. 3, Pt. 27) and Pycnogonida (vol. 3, Pt. 58). The Isopoda and Tanaidacea in the waters around Iceland (including the Faroes and Greenland) have been dealt with already by H. J. Hansen (Danish Ingolf Expedition 1913, 1916). Saemundsson (1937) has recorded the Icelandic Isopods from the Reykjavik Museum, and Stephensen himself (1929) has given a list of the species from Iceland in depths from 200 (300) metres. In the present work, the Isopods from 0–300 metres (the limits of the shelf) number 42 species and the Tanaidacea 9. *Aega tridens* alone is noted from Iceland for the first time. As the author points out, the comparatively small number of species is no doubt partly, but not exclusively, due to the somewhat isolated site of the island and is thus more apparent than real. The difference between Norway and Iceland is most marked in the very small forms, which have been thoroughly investigated in Norway, whilst the large easily noticed species occur nearly equally in both regions. Most of the Isopods and Tanaidacea found around Iceland are widely distributed in the northern part of the Atlantic with adjacent arctic waters. The main interest is connected with the fairly numerous species which are East Atlantic lusitanic-boreal, distributed in the north-eastern part of the Atlantic from the Mediterranean or south-west Europe northwards to Norway, the Faroes and Iceland, but found in Iceland only along the southern and western coasts. The Pycnogonida have not been hitherto so thoroughly investigated. Nineteen species are recorded, down to a depth of 300 metres, four of these for the first time. They are mainly widely distributed in the littoral and sub-littoral zones in the northernmost part of the Atlantic with adjacent arctic waters, with a few representing more special areas of distribution.

Mineral Deficiency affecting Farm Animals

THE extent and influence of mineral deficiency on the growth and reproduction of farm animals have been investigated in Canadian agricultural research centres, as well as elsewhere, and are of special interest as part of the general study of the function of minerals in the thrift of domestic stock. As an aid to the investigation, the National Research Council of Canada has published a bibliography, compiled by Muriel E. Whalley, of papers dealing with mineral deficiencies as affecting the growth and reproduction of farm animals (Ottawa, 1937). The list contains 987 numbered entries arranged in alphabetical order according to authors, and covers the literature to the end of 1936. Cross references to the principal subjects mentioned in the titles have been included to assist the reader in gaining some idea of the scope and nature of the reference listed. Under each subject there is a numerical list of relevant references. The bibliography occupies 89 pages of duplicated typescript matter. The Council announces that a single copy of the bibliography will be sent free to anyone engaged in, or with special interest in, this field of research, on application to the Division of Research Information, National Research Council, Ottawa, Canada.

Larval Crustacea from the Red Sea

IN his series of papers on Decapod larvæ, Dr. R. Gurney has contributed largely to our knowledge. A recent work ("Notes on some Decapod and Stomatopod Crustacea from the Red Sea" (3–5), *Proc. Zool. Soc. London*, Series B, 1937) deals in addition with certain Stomatopod larvæ. The natural position of the Stomatopoda is always a controversial point and the author's remarks on the larvæ are suggestive, showing that in many ways they are nearer to the Euphausiacea than to the Decapoda proper. He is of the opinion, and rightly so, that the difference between the *Lysiosquilla* type (Antizoea) and the *Squilla* type (Pseudozoea) is fundamentally important, showing as it does a different kind of locomotion, on one hand by the thoracic appendages and on the other by the abdominal. He was fortunate in obtaining eggs of *Gonodactylus glabrous*

and the first and second larvæ from them as well as several stages from the plankton, making an almost complete series. *Lysiosquilla* larvæ (almost certainly the first stage), also described, are interesting in being intermediate between the Antizoea and Pseudozoea type, having the head and thorax of an Antizoea but with well-developed pleopods. *Callianassa* larvæ are discussed. Here there is always much that is difficult owing to the lack of definite identification. Two types exist, one (of which *C. subterranea* is an example) being found in a number of widely separated species, the other, less known, being closely related to that of Axius. The larvæ of a species of *Chlorotocella*, regarded as a Pandalid by Balss, is unusual in having the legs exceptionally backward in development and in having no exopods on the last four pairs of legs.

Elm Disease in Great Britain

A BRIEF memorandum on the elm disease was issued by the Forestry Commission in 1934. This Leaflet No. 19 is now reprinted (1938). The elm disease was first discovered in Holland in 1919 and is therefore referred to as the Dutch elm disease (*Ophiostoma ulmi*). It has been noted in Great Britain since 1927 and is fairly widespread over England, but does not extend to the north of Alnwick and is not reported from Scotland. The disease is now common throughout western and northern Europe; also in the United States. Many trees have been killed by it in Belgium, France, Germany, Holland and Italy. The first sign of the disease is a discoloration and withering of the leaves in the crown or at the ends of the branches. This is usually followed by defoliation, dead shoots being characterized by a drooping of the twigs, particularly noticeable in the months of summer. The trouble about this disease and the chief remedy (felling the tree affected) is that the severity of attack and the rate of progress of the disease are very variable. Trees may be killed in a single year, or the dieback may be more gradual, and if left standing they may entirely recover. Trees of all ages may be attacked, but small plants in nurseries and elm hedges are less frequently attacked than older trees. It is said that elms which have been pollarded, or severly lopped, are especially liable to infection. It is also held that the disease is spread by the elm bark beetles, *Scolytus destructor* and *S. multistriatus*; but observers are not at present unanimous upon this point. As regards the present position in Great Britain, between 1927 and 1931 the disease increased steadily. In 1932 there was a definite check, since when the disease has made steady progress, especially rapid in Worcestershire, but even in the worst regions it is said that the proportion actually killed is small. Attacked trees, therefore, should not be felled unless they become unsightly or die.

Fungi of Cyprus

GREATER knowledge of the problems of fungus ecology is one of the surest foundations for economic plant pathology of the future. One of the first requisites is an exact taxonomy of the fungi which occur in regions of characteristic climate. Dr. R. M. Nattrass has ministered to this need by publishing "A First List of Cyprus Fungi" (pp. xvi + 87. Nicosia, Government of Cyprus, price 2*s*. net, 1937). Details of climate and characteristic husbandry are given, and most of the fungi recorded seem to be typical of the Mediterranean region. There appears to be, however, a distinct mycological link with India. Six new species are proposed. Several cosmopolitan parasitic fungi which are usually found in widely varying habitats are absent from Cyprus. *Nectria cinnabarina*, the coral-spot fungus, *Stereum purpureum*, the cause of silver-leaf in plums, *Ophiobolus graminis*, or 'take-all' of wheat, and the wart disease of potatoes, *Synchitrium endobioticum*, are examples. Fifteen plates delineate the characters of the new species and other uncommon fungi.

Assyrian Chemistry of the Seventh Century

DR. R. CAMPBELL THOMPSON delivered a lecture on March 16 to the Society for the Study of Alchemy and Early Chemistry on "Assyrian Chemistry of the Seventh Century B.C." The lecture showed that cuneiform records going back to the seventeenth century B.C. contain recipes for carrying out chemical processes, but the greater part of the abundant literary material is from the seventh century and is in the British Museum. The translation of these tablets by Dr. Thompson has made it possible to reconstruct with considerable probability the range of materials used by the ancient Assyrian chemists, and it is interesting to find that enamels and glasses coloured by metallic oxides and possibly gold were made by processes depending on the use of definite weights of materials. Elaborate lists of stones were drawn up and it seems as if these include scales of hardness similar to the modern Mohs' scale. Various salts were in use, and it is even possible that fuming sulphuric acid was obtained by distilling green vitriol. An account of the lecture will be published in *Ambix*, the journal of the Society.

The Photographic Image

R. W. Gurney and N. F. Mott (*Proc. Roy. Soc.*, A, **164**, 151; 1938) have applied the quantum theory of solid photo-conductivity to the production of the photographic image. If an electron is introduced into the silver halide lattice it is able to jump from ion to ion through the crystal, its energy lying in a band of 'conduction levels'. Such electrons are liberated from the halogen ions by the action of light, and whenever they come in contact with a speck of metallic silver they are captured. The negatively charged silver specks then attract silver ions which have left their normal lattice positions as a result of heat motions. This explains the direct darkening of silver halides by light (print out effect). It is clear that the efficiency of the process will be reduced at low temperature, and this is in agreement with experiment. The formation of the developable 'latent' image is due to the production of a submicroscopic silver speck on the surface of a halide grain. The well-known sensitizing effect of traces of sulphur may be due to the sulphide specks localizing the formation of silver specks at points on the surface of the grain where the developer can get at them. It is shown that the silver specks will not be able to grow unless a certain concentration of electrons is provided by the photo-electric action, and on this basis the relations between time of exposure, intensity of light and blackening may be explained. There is a short discussion of the reversal of the image by red light and of the sensitization of emulsions by dyes.

Quantitative Methods in Psychology

A MEETING of the Royal Society was held on March 24 to discuss the application of quantitative methods to certain problems in psychology. The discussion, which was on three different problems, was introduced by Dr. C. S. Myers, who pointed out that conscious experience can only be measured numerically in terms of the antecedent physical stimulus, the concomitant physiological activities, or the consequent changes in outward behaviour. If mathematical operations on psychological data are to be of psychological value, each step in such operations must be carefully studied so as to be assured that it is psychologically warranted and not merely of interest to the mathematician. The psychological whole being greater than the sum of its parts, and the nature of these parts being dependent on the whole, the limitations of psychological atomism and psychological mechanics must always be borne in mind. But even if factorial analysis, although mathematically possible, may have only a limited use in applied psychology, nevertheless occupational guidance and selection, as at present practised, are demonstrably of considerable value.

Statistical Methods

Prof. C. E. Spearman, who opened the first discussion, on recent developments of statistical method, described the development of factorial analysis as illustrated by his own work and that of Kelley, Thurstone and Holzinger. Prof. G. H. Thomson said that in his view vocational prediction entails the projection of a point, given by n oblique co-ordinate axes called 'tests', on to a vector representing the 'occupation', the direction cosines of which are known but which is not in the n-space of the tests. The use of factors, whether oblique or orthogonal, merely involves reference of that point to a new set of co-ordinate axes called 'factors', instead of to the original test-scores—a procedure which, he argued, cannot define the point any better and may, unless great care be taken, define it worse. The chief value of the factor theory probably lies in its serving as a spur to further investigations and hypotheses. His belief is that the comparatively low rank to which so many matrices of mental correlation coefficients can be reduced indicates that the human mind is comparatively undifferentiated, protean and plastic, rather than that it is composed of separate faculties.

Prof. C. Burt regarded the factors isolated by analysis as merely convenient descriptive concepts which may, or may not, have a psychological basis. They need have no 'real existence', but serve much the same purposes as the lines of latitude or longitude upon a terrestrial map. In statistics the important measurement is not that of the clue and its consequence, but the measurement of the probability connecting the two. He referred to the great value of R. A. Fisher's formulæ for small samples, before the discovery of which it was considered that statistical methods could not be applied to less than 50 or 100 cases, and consequently the more detailed studies of the individual tended to give place to vast collections of inaccurate data. He also alluded to the easy comprehension and to the great value of matrix algebra for analytical purposes in statistical psychology—a method rarely utilized in the text-books of pure statistics; and to certain close analogies between recent developments in factor psychology and those in quantum mechanics.

A discussion of this subject followed by Drs. H. B. Heywood, J. O. Irwin and W. Stephenson.

Industrial Accidents and Sickness

Prof. M. Greenwood introduced the next subject—industrial accidents and sickness. He described how his early work at the Ministry of Munitions in 1918, on the distribution of accidents among those exposed to the same risk of them, led to later investigations conducted with the object of arriving at a statistical expression of the true and popular view that some people are 'all thumbs'. He was followed by Dr. May Smith, who gave an account of investigations conducted by the Industrial Health Research Board into the comparative absenteeism through sickness of those employed in selling, office work and manufacture. She indicated how dependent absenteeism also is on age, sex, incentives and management.

Mr. Eric Farmer and Mr. E. G. Chambers contributed to the discussion of this subject by describing their work on tests for the 'accident-prone', which provide with fair accuracy a prediction of accident rate for different groups of workers, although they are not sufficiently reliable in the case of any individual worker.

Industrial Selection

The last discussion, on psychological tests in industrial selection, was opened by a communication from Sir Frederick Marquis, who described the promising value of special tests for salesmanship introduced a year ago into Lewis's stores, but had found tests for general intelligence to be of no value. Mrs. Raphael pointed out that in another large stores the National Institute of Industrial Psychology had found no linear correlation between intelligence and retail salesmanship, too much intelligence being as undesirable a qualification as too little.

Wing Commander R. H. Stanbridge described an experiment on the selection of aircraft apprentices with the aid of psychological tests. He found tests of intelligence and mechanical aptitude to be correlated with the passing-out results and to be definitely serviceable. Dr. W. G. Hiscock described the use of selection tests devised by the National Institute of Industrial Psychology for the Grangemouth branch of the Dye-stuffs Group of Imperial Chemical Industries, Ltd. Since 1934 all applicants for employment in the works have been submitted to these tests, as well as to a special medical examination, and not a single chemical process-worker has been discharged on the ground of inefficiency. Dr. Millais Culpin gave an account of an interesting investigation into the relation between 'nervousness' and the satisfactory and continued work of telegraph operators.

Discovery of the Femur and the Humerus of *Sinanthropus Pekinensis*

By Prof. Franz Weidenreich

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THE FEMUR

AMONG the extensive material recovered from Locality 1 at Choukoutien during the excavations of 1936–37 and afterwards prepared in the Laboratory, Dr. W. C. Pei discovered two fragments of femora. The general appearance of these specimens led Pei to believe that they were of human origin and probably belonged to *Sinanthropus*. A careful study and comparison with human and anthropoid thigh-bones resulted in the conclusion that the femora undoubtedly belong to *Sinanthropus*.

Fig. 1.

COMPARATIVE VIEW OF THE ANTERIOR SURFACE OF FEMORA: (*a*) *Sinanthropus* FEMUR *J*; (*b*) *Sinanthropus* FEMUR *M*; (*c*) THE FRAGMENT OF A FEMUR OF THE MAN OF WEIMAR-EHRINGSDORF (NEANDERTHAL GROUP) WHICH HAS NOT BEEN DESCRIBED (CAST); (*d*) FEMUR OF A FEMALE INDIVIDUAL OF RECENT MAN (MORAVIAN)—UPPER AND LOWER PARTS REMOVED TO CONFORM TO THE SIZE OF THE *Sinanthropus* FEMUR *M*. (×3/10.)

Femur fragment I was recovered from Level 23 in the western area of the cave, that is to say, Site *J*, from which we already have several fragments of an adult female skull described as Skull *J* in 1937, and four skull fragments of a very young child recently found among the prepared material. Femur fragment II comes from Level 26 of the western area of the cave, from which we have two fragments of one adult male and one adult female mandible as yet not described. Femur specimen I will be known as Femur *J* and specimen II as Femur *M*.

Femur *J* (Figs. 1 and 2, *a*) represent a portion of the middle of the shaft and measures 58 mm. The bone is completely fossilized and burnt, as is evident by the marked blackening of the entire anterior and medial surface and on the part where it was broken off. That we are actually dealing with a human femur is demonstrated by the form and size, but particularly by the existence of a rather distinct pilaster (Broca) which occupies the middle of the posterior surface and bears a well-developed linea aspera dividing into characteristic medial and lateral lips toward the end of the fragment.

Femur *M* (Figs. 1 and 2, *b*) embraces almost the entire diaphysis. Its length is 312 mm. At the upper end, the head and trochanters are broken off, whereas the entire inferior border of the neck is preserved. The lower end is likewise missing but the upper end of the suprapatellar fossa is still recognizable. This femur also is strongly fossilized. Certain parts of the surface are weathered but all the characteristic features are sufficiently preserved to permit a criterion. Like specimen *J*, this piece shows a distinct pilaster running along the middle of the posterior surface and bears a linea aspera consisting of two lips. Its relative completeness, however, makes it possible to determine the general form and the peculiarities of the shaft. Estimated on the basis of the length of the preserved portion of the femur, the total length may have been 400 mm.

The femur of *Sinanthropus* has, in common with that of recent man (Figs. 1 and 2, *d*), the general shape and the formation of a pilaster with a two-lipped linea aspera. In addition, there is a suprapatellar fossa, its lateral border being formed by a distinct ridge which gradually disappears towards the middle of the shaft. The trochanter tertius and the intertrochanteric line are missing. On the other hand, the femur differs from that of recent man by its stoutness—it seems that the distal end in particular was shorter and broader than in recent man in proportion to the length and breadth of the femur—and by the following specific features: (1) a very pronounced platymery of the entire length of the femur combined with the formation of a distinct pilaster (Figs. 2 *b*; 3 *a-c*); (2) a very faint curvature the greatest height of which is located near the lower

end of the diaphysis (Fig. 2 *b*); (3) the transversal diameter of the shaft is narrowest near the lower end and gradually increases toward the upper portion (Fig. 1 *b*); (4) there is a distinct but only faintly developed crista lateralis superior (Fig. 1 *b*); (5) sections show that the cavity is narrow with rather thick walls, especially the anterior and posterior ones (Fig. 3 *d*).

Femora of the Neanderthal group (Figs. 1 and 2, *c*) differ from the femur of *Sinanthropus* by their greater stoutness, the transversal diameter being narrowest in the middle of the shaft, by a much more pronounced curvature the greatest height of which is also located near the middle of the shaft, and finally by the development of a very strong crista lateralis superior (Fig. 1 *c*). To what extent these differences are due to sexual characters is difficult to define. It seems that all the femora available of the Neanderthal group belong to male individuals, whereas I consider the two femora of *Sinanthropus* as belonging to females on account of the smallness of the two main diameters of the shaft (Table 1, Figs. 1 *b* and 2 *b*). In addition, femur *M* comes from the same site as a fragment of a lower jaw (*M* I) with two teeth which had been attributed to a female individual.

When compared with the femora of the great apes, those of *Sinanthropus* represent quite a different type. The general character of the shaft does not conform to any of them. It is of special interest that the *Sinanthropus* shaft also fails to show any similarity to that of a gibbon, the shaft of the latter being slender as in recent man, with the narrowest part at its middle. It may be deduced from this fact that the frequently stated similarity between femora of gibbon and recent man is of secondary nature and not in the least a fundamental one.

These discoveries of the *Sinanthropus* femora may also serve to shed some new light upon the problem connected with the *Pithecanthropus* femur. Its discoverer, E. Dubois, attributed it as belonging to the same individual or type as that represented by the *Pithecanthropus* skull cap. The fact that the femur closely resembled one of recent man not only in respect to its general character but also in certain other details was at no time held in doubt and distinctly admitted by Dubois. According to him, one of the most essential differences between the femur of *Pithecanthropus* and that of recent man should be a pronounced convexity of the upper portion of the popliteal surface of the former.

Femur *M* of *Sinanthropus* differs from the *Pithecanthropus* femur by exactly those features by which it differs also from that of recent man. But with reference to the popliteal surface it shows the same slight convexity as is common in recent man, the platymeric index of this region being 76·4 in *Sinanthropus* against 100·0 in *Pithecanthropus* (Table 2). The convexity of the popliteal surface of the *Pithecanthropus* femur, therefore, cannot be considered a primitive character.

It results from these facts that the *Pithecanthropus* femur is either one of recent man and with no close relationship to the skull cap, or it really belongs to the latter and thereby testifies that *Pithecanthropus* represents a much more advanced hominid type than *Sinanthropus*. I consider the first alternative to be the correct one. As proved by the skulls, both *Sinanthropus* and *Pithecanthropus* exhibit in general approximately the same degree of primitiveness. On the other hand, the femur of *Sinanthropus* reveals that the *Pithecanthropus* femur, besides other differences, is much too long and too strong for so small a skull.

In a lecture delivered in December 1937 before the Peking Society of Natural History, I pointed out that the character of the then available specimens of

Fig. 2.
THE SAME FEMORA AS IN FIG. 1 VIEWED FROM THE LATERAL SIDE. (× 3/10.)

extremity bones of *Sinanthropus*, particularly the collar bone, indicated a more man-like appearance than the skulls and more especially the teeth. On the basis of this, together with the cultural remains, I came to the conclusion that *Sinanthropus* must have already adopted a completely upright posture and that the approach of the extremity bones to those of man preceded that of skull and teeth. Such a conception has now been confirmed by the discovery of the femur of *Sinanthropus* and thus leaves no room for doubt that the posture of *Sinanthropus* was erect. Since the total length of the femur (female) may have approximated 400 mm., the stature of the woman can be estimated to have been about 5 feet (152 cm.), a height which would correspond

to 5 ft. 4½ in. for male individuals. With such a height, *Sinanthropus* ranges within the group composed of medium-sized people of to-day. At any rate, it is certain that *Sinanthropus* was not a pygmy.

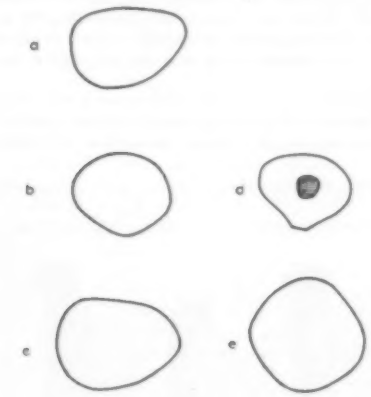

Fig. 3.

SECTIONS OF *Sinanthropus* AND *Pithecanthropus* FEMORA: (*a*) *Sinanthropus* FEMUR *M*, IMMEDIATELY BELOW THE LESSER TROCHANTER; (*b*) THE SAME FEMUR, SECTION OF THE MIDDLE OF THE SHAFT; (*c*) THE SAME FEMUR, SECTION OF UPPER PART OF THE SUPRAPATELLAR FOSSA; (*d*) *Sinanthropus* FEMUR *J*, SECTION OF THE MIDDLE OF THE SHAFT WITH THE CAVITY MARKED; (*e*) *Pithecanthropus*, SECTION OF THE UPPER PART OF THE SUPRAPATELLAR FOSSA IN CORRESPONDENCE TO SECTION *c* OF *Sinanthropus* FEMUR *M*. (× ½.)

The three facts, namely, that the two femora were found as isolated pieces without any other human bones; furthermore, that they represent only more or less complete specimens, and finally that the fragment of femur *J* was burnt, point in the same direction as the finds of skull and jaws. All the *Sinanthropus* bones recovered from Locality 1 of Choukoutien had received the same treatment as the game which *Sinanthropus* hunted. This hominid, therefore, was a cannibal. *February 10.*

TABLE 1.

PRINCIPAL MEASUREMENTS OF FEMORA (IN MM.).

	Sinanthropus M ♀	*Sinanthropus J* ♀	*Pithecanthropus* ♂
1. Transversal diameter			
(*a*) upper end	34·3	—	34·6?
(*b*) middle	29·0	27·3	28·0
(*c*) upper popliteal region	36·0	—	34·3
2. Sagittal diameter			
(*a*) upper end	22·1	—	31·0
(*b*) middle	24·1	22·6	29·0
(*c*) upper popliteal region	27·5	—	34·3
3. Circumference (middle of shaft)	88·0	77·0	89·0

THE HUMERUS

Shortly after the discovery of two fragments of the femur of *Sinanthropus pekinensis*, Dr. W. C. Pei recognized, among the material of Locality 1 of Choukoutien now in preparation in the Laboratory, a fragment of a humerus. This fragment comes from the same level (23) as the femur fragment *J*, but was found about 13 m. away from the latter.

The fragment is strongly fossilized and represents the greater part of a left diaphysis the total length of which is 187 mm. Both end parts are missing and apparently broken away previous to the process of fossilization. There is no doubt that the humerus belongs to *Sinanthropus*, its general appearance being rather similar to that of Neanderthal or recent man. But at the same time conspicuous differences are evident, namely, the diaphysis is very slender, the smallest circumference being only 60 mm. and the

TABLE 2.

INDEXES AND ANGLES.

	Sinanthropus M ♀	*Sinanthropus J* ♀	*Pithecanthropus* ♂	Neanderthal ♂	Recent Man	Gorilla	Chimpanzee	Orang	Gibbon
1. Length-circumference index	22·0 (?)	—	19·5	22·3	♀ 17·5–21·3	♀ 31·0	♀ 33·7	♀ 30·3	♂ ♀ 18·1
2. Robusticity index	17·3 (?)	—	12·5	13·5–14·1	11·7–12·5	17·2	15·7	♂ ♀ 15·7	10·8
3. Pilastric Index	84·0	84·0	103·8	99–100·5	100–122	♂ ♀ 75·4	♂ ♀ 84·6	78·5	97·1
4. Platymeric index:					♂	♂ ♀	♂ ♀	♂	
(*a*) upper end	64·5	—	89·8? or more	69·8–85·3	64·3–85·9	81·0	82·8	71·2	82·8
(*b*) popliteal region	76·4	—	100·0	—	—	♀ 66·3	♂ 80·3	66·9	—
5. Index of the curvature (after Ried)	2·03	—	2·15	5·0–5·5	3·3 (1·8–5·0)	♀ 2·73	♂ 2·88	♂ 1·86	—
6. Indexes of the position of the vertex of the curvature (after Ried)						♀	♂	♂	
(*a*) Index I	35·9	—	47·2	—	—	57·5	55·3	55·8	—
(*b*) Index II	37·5	—	46·3	43–45·1	56·0	48·7	52·9	50·4	—
7. Index of the robustness of the wall					♀				
(*a*) ant. wall	37·1	30·1	—	—	23·9				
(*b*) post. wall	37·1	40·7			33·4				
(*c*) lat. wall	39·4	39·7			34·2				
(*d*) med. wall	30·8	36·3			24·7				
8. Collar angle	circa 110°	—	123°	115–120°	121–133°	115°	120°	130°	130°

circumference immediately below the surgical neck only 71 mm. The markings of muscle insertion, however, are surprisingly well pronounced, especially those of the deltoid and pectoralis major. The tuberositas deltoidea continues in a ridge-like projecting crest, the total length of which is 15 mm. The crista tuberculi majoris is likewise strongly developed, and there is also a well-circumscribed tuberositas corresponding to the attachment for the m. teres major. The sulcus radialis is also rather distinct, indicating a well-developed torsion of the humerus. In addition, the borders represent sharply demarcated edges, so that a cross-section of the upper part shows an almost quadrangular outline, while one of the lower parts beyond the end of the tuberositas deltoidea has the form of a real triangle. These features combined give the humerus of *Sinanthropus* a specific character.

In view of the deficiency of the fragment, it is not possible to determine with any degree of certainty the original length of the humerus. On the basis of the form and length of the fragment, however, the total length may be estimated to have been at least 310 mm. Despite the strong development of the muscle markings and the edge-like character of the borders, I consider the humerus as belonging to a female individual on account of its extraordinary slenderness.

As is evident from this brief description, the humerus of *Sinanthropus* does not show any special similarity to the humeri of great apes. It is specifically human in its entire appearance. The strong development of the muscle markings, especially those of the deltoid, pectoralis major and teres major and the edge-like character of the borders indicate that the upper limb was used in the same manner as in recent man, that is to say, it was already completely freed from locomotion. So far as is possible to deduce from the fragments of femur and humerus, their proportion in length may have been the same in principle as in recent man.

The view I have recently put forward that the skeleton of *Sinanthropus* approached that of man much closer than the brain case and the teeth do, receives additional support by the discovery of the humerus.

February 17.

Science News a Century Ago

Medical Missions

THE March issue of 1838 of the *Gentleman's Magazine* contains the following information: "The first evening meeting of the Royal College of Physicians was held in Trafalgar Square on February 5, and a more crowded audience of members and visitors has, perhaps, never occurred. Amongst the latter were his Royal Highness, the Duke of Cambridge, the Duke of Wellington, the Archbishop of Canterbury, the Bishop of London, the Chief Justice of the Common Pleas, Sir Lancelot Shadwell, Sir Robert Peel, etc., etc. The President, Sir Henry Halford, read a paper recommending in eloquent terms the union of medical with theological knowledge in the attainments of missionaries to the eastern nations, and pointing out the great advantages which would result from such a connexion. He observed that great progress had been made in China and the other Asiatic countries in the healing art by the energy of the missionaries, and that vaccination and other European improvements in medicine had been introduced by their instrumentality. Sir Henry also took a view of the state of national physiology and pathology as understood in China, and pointed out the absurdities of the system of the natives."

English Physicians in France

THE issue of the *Lancet* of March 31, 1838, contains the following information: "The affair of the English physicians in France (prosecution for unauthorised practice at Boulogne) has terminated in the condemnation of Drs. Carter, Scott, Shuter, Allatt and Galbraith to the payment of a trifling sum, which, however, is equivalent to an interdiction from practising medicine in France. This decree has naturally been very unsatisfactory to the British residents at Boulogne who have forwarded a petition to the King of the French on the subject; but their application will probably be of no avail, for we have been informed that, at a recent meeting of the Senate of the University of France, not less than ten demands from foreign physicians for permission to practise have met with a decided refusal. A leading French journal suggests that physicians furnished with diplomas from any foreign university or chartered body should be immediately admitted to the final examination (at a reduced fee) before the Faculty of Medicine of Paris. This appears to be the only feasible way of compromising the matter."

Faraday's Researches in Electricity

ON April 5, 1838, at a meeting of the Royal Society, the reading of Faraday's Thirteenth Series of "Experimental Researches in Electricity" was resumed and concluded. "The author, in this paper," said the *Athenæum*, "pursues the inquiry into the differences observable in the luminous phenomena of the electric discharge, according as they proceed from bodies in the positive or the negative states, with a view to discover the cause of those differences. For the convenience of description, he employs the term *inductric* to designate those bodies from which the induction originates, and *inducteous* to denote those whose electric state is disturbed by this inductive action. . . . He also directed his attention to the peculiar luminous phenomena attending the disruptive electrical discharge, which he terms a glow, . . . and the *convective*, or carrying discharge—namely that effected by the translation of charged particles from one place to another. He lastly considered electric currents, not only in their effects on the bodies they traverse, but also in their collateral influences, as producing inductive and magnetical phenomena. He announced his intention shortly to give further views he entertains concerning the nature of electric forces and electric excitation in connexion with the theory he had advanced."

The Ant-tree of Guiana

AT a meeting of the Botanical Society on April 6, 1838, the Secretary read a paper from R. H. Schomburgk (still in British Guiana) on the *Triplaris Americana*, the ant-tree of Guiana. The trunk, the letter said, is slender, grows up straight, and its erect branches form a pyramid. It is unisexual; and the flowers of both sexes are insignificant: those of the male last only for a few days, when they dry up; this is likewise the case with the petals of the female. The segments of the calix, however, continue to grow from green to white and vermilion, and become so attenuated that the branched nerves are easily

perceptible. The tree presents a most elegant appearance. The incautious botanist who, allured by the deceptive appearance, should approach to pluck the blossoms, would rue his attempt. The trunk and branches are hollow like those of the trumpet tree (*Cecropia*) and provided between space and space with partitions, which answer to the position of the leaves on the outside. These hollows are inhabited by a light brownish ant, about two- to three-tenths of an inch long, which inflict the most painful bites, causing swelling and itching for several days. If they find themselves captured, they attack and kill one another like scorpions. The Aramah Indians call the tree 'Jacuna' and the ant 'Jacuna Sae'.

The British Association and Steam Navigation

AT the Liverpool meeting of the British Association in 1837, a grant was placed at the disposal of a committee to investigate the speed and fuel consumption of steam vessels, and the Peninsula Steam Navigation Company had liberally offered to co-operate with the committee in trials to be made in their ship the *Tagus*. With the view of making the necessary records, Dr. Lardner had made an apparatus which would enable the steam engine to make a journal of its own proceedings.

According to the April 1838 number of *The Civil Engineer and Architect's Journal*, his apparatus was intended to record the pressure of steam in the boiler, and in the engine, the vacuum in the condenser, the revolutions of the paddlewheel, the amount of water in the boiler and its density. The records were made by coloured pencils on a paper driven by clockwork, the apparatus being enclosed in a case 3½ ft. high and 3 ft. in diameter which was to be locked at the beginning of a voyage and was not to be opened until the ship returned to port. The coal consumed was to be ascertained from the amount on board at the beginning and the end of the voyage.

University Events

CAMBRIDGE.—J. A. G. de Courcy has been appointed superintendent of the Engineering Workshops.

The Managers of the Frank Edward Elmore Fund have appointed Dr. J. C. Sinclair to a studentship.

J. R. Robinson, of Emmanuel College, has been awarded the Allen scholarship.

LEEDS.—C. L. Bird has been appointed lecturer in dyeing.

LIVERPOOL.—Dr. Rupert Montgomery Gordon, director of the Sir Alfred Lewis Jones Research Laboratory, Freetown, Sierra Leone, has been appointed to the Dutton Memorial chair of entomology in succession to Prof. W. S. Patton, who resigned in December last.

LONDON.—Dr. F. R. Winton has been appointed, as from October 1, 1938, to the University chair of pharmacology tenable at University College. Since 1933 he has been reader in physiology in the University of Cambridge.

Dr. R. V. Christie has been appointed as from April 1 to the University chair of medicine tenable at St. Bartholomew's Hospital Medical College. Since 1935 he has been assistant director of the Medical Unit and assistant physician at the London Hospital.

Societies and Academies

Paris

Academy of Sciences, January 31 (*C.R.*, **206**, 289–384).

ERNEST ESCLANGON: Clocks indicating simultaneously mean solar time and sidereal time. It is possible to have a master clock, showing mean solar time, connected by a train of wheels to another clock showing sidereal time. The choice of the number of teeth on the connecting wheel work is worked out and a number of examples given showing the gear train and the corresponding error in seconds after 100 years starting with 1938.

GABRIEL BERTRAND and GEORGES BROOKS: The composition of fibres, shells and other lignified plant tissues. Studies from the point of view of the chemical or biological utilization of these plant products.

DIMITRI RIABOUCHINSKY: Comparison of the method of the variables $(\varphi, \psi_1, \psi_2, t)$ with those of the variables of Euler and of Lagrange.

MARCEL GODCHOT and MLLE. GERMAINE CAUQUIL: The molecular transpositions obtained in the dehydration of the 1-methyl-3-cyclohexylisopropyl pinacones.

EDOUARD CHATTON: The plurality of the species of *Orchitosoma* and on their nature: the spermatogenetic evolution of Metazoa taking place in the parasite state in the ovary of Copepods.

JULES DUBOURDIEU: Remarks relating to the theory of assurance accidents.

WOLFGANG DŒBLIN: First elements of a systematic study of the ensemble of powers of a law of probability.

KARL MENGER: A simplified axiomatic of the algebra of projective geometry.

GUSTAVE CHOQUET: Study of certain networks of routes.

ANDRÉ LICHNEROWICZ: Regular space-time exteriors.

LOUIS SACKMANN: The comparative study of the *portance* of a wing of an aeroplane and of the régime of flow on the extrados.

JEAN MANDEL: The equilibria through plane parallel sections of plastic media at the limit of flow, and, in particular, of earth and of the ductile metals.

JEAN LOUIS DESTOUCHES: Centre of gravity and relations of uncertainty.

MLLE. NATALIE REIN: A form of differential equations of the limited elliptical problem.

ANDRÉ DANJON: The determination of the elements of the orbits of visual double stars.

JOSEPH MIKULAŠ MOHR: The dependence of the observed radial velocity and of the term K of stars of type B with distance.

DIKRAN G. DERVICHIAN and MAURICE JOLY: Homogeneous transformation points in monomolecular layers.

CONSTANTIN SALCEANU and CORNELIU ISTRATY: The determination of the positions of resonance in tubes by means of a galvanometric deviation. An application of the resonance method of Bungetzianu, in which the telephone method of defining the resonance positions is replaced by a galvanometer method. Results obtained with water, alcohol, acetone and carbon tetrachloride are given graphically.

RAYMOND ZOUCKERMANN: The variations of the explosive potential of a discharge tube without internal electrodes, under the influence of ultra-violet or visible light. The curve showing the relation

between the explosive potential in hydrogen, in a tube with external electrodes, and the pressure of the gas, is changed when the gas is exposed to light, the explosive potentials being always lower in the latter case. The cause of this phenomenon is obscure.

AMÉDÉE GUILLET : Vagueness in the working of systems formed, like the microphone and the coherer, of a large number of associated elementary contacts.

MLLE. MILKA RADOÏTCHITCH : The influence of the solvent on the infra-red absorption spectra of various solutions of neodymium and samarium acetylacetonates. The infra-red absorption bands of salts of the rare earths in solutions of organic solvents undergo displacements and variations of intensity depending on the solvent, a result analogous with that already found in the visible spectrum.

MAURICE PARODI : Study of the transmission of some benzene derivatives in the extreme infra-red.

PIERRE GRIVET : The modulation of light at high frequency. Its application to the measurement of very short periods of time.

JACQUES RABINOVITCH : The magnetic double refraction of benzene solutions of the pinenes.

MLLE. YVETTE CAUCHOIS and MLLE. MARIE LOUISE ALLAIS : The *L* spectra of emission and absorption of thorium and its characteristic levels.

PIERRE AUGER : The new heavy particles of cosmic radiation.

MARC FOËX : The solubility of oxides in fused boric anhydride at 1200° C. Experimental data for the solubility of various metallic oxides in fused boric oxide at 1200° C. are given. From the figures it is concluded that the solubility of the oxides varies regularly with the molecular weight. Several oxides, hitherto considered as insoluble in fused boric oxide, have in reality an appreciable solubility.

GUY GIRE and FRANÇOIS FOUASSON : Basic selenates and tellurates.

FRANÇOIS OLMER : The reduction of the oxides of iron by carbon monoxide in the presence of some natural impurities. The catalytic action of iron on the decomposition of carbon monoxide is impeded, or even entirely stopped, by the presence of phosphoric anhydride or of alumina.

JACQUES PARROD : A reaction of ethyl dihydroxymalonate. Application to the detection of mesoxalic acid. The reaction between ethyl dihydroxymalonate, zinc sulphate and ammonia produces an intense green fluorescence.

GASTON GIBAULT : The magnetic disturbance of January 25, 1938.

CHARLES MAURAIN : Remarks on the preceding communication.

ROGER FAILLETTAZ : An anemometer with photoelectric cells for the study of atmospheric turbulence.

ROBERT BUREAU : Ionospherical disturbances starting suddenly and their effects on the long waves.

MARIUS CHADEFAUD : The plasts and amylogenesis in the Dasycladaceæ.

GEORGES MANGENOT : The oospheres, the pollen tubes and fertilization in the maritime pine.

ANTONIN TRONCHET : The optical properties of the papillous cells of the tendrils of *Eccremocarpus scaber*.

M. and MME. FERNAND MOREAU : The hormonal formation of the perithecium in the Neurospora.

ANDRÉ HOLLANDE : The parabasal apparatus of the Cryptomonadines.

MAURICE FONTAINE and RENÉ GUY BUSNEL : The localization of the role of flavine or of a body similar to flavine in the skin of fish.

ANTOINE MAGNAN, CHARLES PERRILLIAT-BOTONET and HENRY GIRERD : Simultaneous cinematographs in three perpendicular directions, two by two, of a bird in flight.

SERGE TCHAKHOTINE : Experimental parthenogenesis of the egg of the *Pholas* by ultra-violet micropuncture, terminating with a living larva.

MARCEL MAZILLE : A dry and irreversible dialysis of blood serum.

ALEXANDRE BESREDKA : The disappearance of the vaccinating power of diphtheric anatoxin in the presence of antidiphtheric serum. Whilst the anatoxin, injected alone, exerts an immunizing power, it ceases to have this influence in the presence of antidiphtheric serum. The animal behaves as if the anatoxin were annihilated by the serum.

HENRI VIOLLE : Contribution to the study of endemic exanthematic typhus.

P. G. CHARPENTIER, MAURICE DOLADILHE, CHARLES MOREL and LOUIS PLACIDI : The anaphylactizing properties of the blood serum are localized in the viscous protein of this serum.

Prague

Czech Academy of Sciences and Arts

January 15, 1937.

J. MILBAUER and J. VODRÁŽKA : Simultaneous estimation of SeO_3'', SeO_4'', AsO_3''', AsO_4'''. Arsenates are precipitated by magnesium solution, arsenites are oxidized to arsenates by ammoniacal H_2O_2 ; selenates are estimated as $BaSeO_4$ by using $Ba(ClO_4)_2$ instead of $BaCl_2$.

FR. KOSTEČKA : Transplantation of tooth germs.

R. BRDIČKA : The application of the polarographic protein reaction for cancer diagnosis. The polarographic estimation of proteins in blood serum shows that the results in cases of cancer are distinctly lower than in normal cases, provided that time is allowed for the denaturation of the proteins.

J. GOLL : Metallography of nickel ores from Dobšina.

K. ŽEBERA : The Cretaceous formation at Kladno.

FR. FUČÍKOVÁ : An anthropometric contribution to rib morphology.

March 12, 1937.

FR. NĚMEJC : The cone called Discinites Feistmanteli.

J. WOLF : The surface relief of resorption cells.

E. VOTOČEK : The carbohydrates of papyrus pith (*Cyperus papyrus*).

E. VOTOČEK and R. MÜLLER : New reagents for the identification of ketoses.

E. VOTOČEK and O. WICHTERLE : Additive products of hydrocyanic acid, glycosylarylamines, and glycosylpiperidines.

B. NĚMEC, J. BABIČKA and I. SMOLER : Spectroscopic and chemical estimation of gold in plants. The amount of gold in the ashes of various plants was determined, and found to be surprisingly high in some specimens.

Z. KÖCHER : The influence of higher sulphonated alcohols on the resorption through the epithelium of the gastro-intestinal tract.

J. KOROUS : Development of the functions of one real variable into a series of certain orthogonal polynoms.

V. RYPÁČEK and T. MARTINEC : Dependence of the titration acidity of soil suspension and soil filtrate on the size of the soil particles.

R. KETTNER : Geological structure of the northern slope of Kralova Hole near Liptovská Teplička (Low Tatras).

Forthcoming Events

Thursday, April 7

BRITISH MEDICAL ASSOCIATION, at 8.—Dr. H. Crichton-Miller: "Mental Health as a National Problem" (Sir Charles Hastings lecture).

INSTITUTION OF NAVAL ARCHITECTS, April 6–8.—Annual meeting to be held at the Royal Society of Arts, John Street, Adelphi, W.C.2.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

PROFESSOR OF EDUCATION in the University of Cambridge—The Vice-Chancellor (April 18).

LECTURER IN HYGIENE AND BIOLOGY in the Avery Hill Training College, London, S.E.9—The Education Officer (H.2/1), County Hall, London, S.E.1 (April 30).

UNIVERSITY LECTURER IN GEOGRAPHY in the University of Cambridge—Dr. F. C. Phillips, Department of Mineralogy and Petrology, Cambridge (April 30).

UNIVERSITY READER IN MATHEMATICS in the Imperial College, Royal College of Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 2).

DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY in the Royal Holloway College, Englefield Green, Surrey—The Principal (May 7).

JUNIOR LECTURER IN METALLURGY in the University of the Witwatersrand—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (May 31).

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 57: Conidia from Infected Bud-Scales and Adjacent Wood as a Main Source of Primary Infection with the Apple Scab Fungus *Venturia Inaequalis* (Cooke). By R. McKay. Pp. 623–640+19 plates. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2*s*. [93

Board of Education: Science Museum. One Hundred Years of Transatlantic Steam Navigation, 1838–1938: a Brief Outline of the History and Development of the Atlantic Ferry since the Advent of the Steamship, as illustrated by a Special Exhibition at the Science Museum. By H. P. Spratt. Pp. 24+3 plates. (London: H.M. Stationery Office.) 6*d*. net. [93

National Physical Laboratory. Notation for Piezo-electric Quartz. Pp. 10. (London: H.M. Stationery Office.) 3d. net. [93

Student Health: the Report of an Inquiry into University Health Services by the National Union of Students. Pp. 104. (London: National Union of Students.) [93

University of Sheffield. Report on Research Work carried out in the Departments of Mining and Fuel Technology during the Session 1936–1937. Pp. 20. (Sheffield: The University.) [103

Proceedings of the Royal Irish Academy. Vol. 44, Section A, No. 5: On the Uncertainty Relations in the Measurement of Space–Time. By R. W. Ditchburn and H. Motz. Pp. 45–76. 1*s*. Vol. 44, Section A, No. 6: The Creation of Electron Pairs by Nuclear Capture of Neutrons. By H. S. W. Massey. Pp. 77–86. 1*s*. Vol. 44, Section A, No. 7: Negative Ions in Discharge Tubes. By K. G. Emeléus and J. Sayers. Pp. 87–100. 1*s*. Vol. 44, Section A, No. 8: On Functions of Quaternions. By Dr. V. C. A. Ferraro. Pp. 101–108. n.p. Vol. 44, Section B, No. 5: The Geology of the Rathmullan District, Co. Donegal. By William J. McCallien. Pp. 45–60+3 plates. 1*s*. 6*d*. Vol. 44, Section B, No. 6: The Mammals of Ireland. By C. B. Moffat. Pp. 61–128. 2*s*. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) [143

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 6: The Rôle of Albumen in Cheese-Making. By G. T. Pyne and L. ó Droma. Pp. 75–82. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*. [153

Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 58: Annual Changes in the Osmotic Value of some Arctic and Temperate Plants. By Elizabeth Mary Wager and Dr. Harold Geoffrey Wager. Pp. 641–653. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*. [153

British Museum (Natural History). Great Barrier Reef Expedition 1928–9. Scientific Reports, Vol. 6, No. 1: The Larvae of the Decapod Crustacea: Palaemonidae and Alpheidae. By Dr. Robert Gurney. Pp. 60. (London: British Museum (Natural History).) 5*s*. [163

Report of the Marlborough College Natural History Society for the Year 1937. Pp. 63. (Marlborough: Marlborough College Natural History Society.) Members, 3*s*.; Non-members, 5*s*. [163

Other Countries

Memoirs of the Faculty of Science and Agriculture, Taihoku Imperial University. Vol. 18, No. 11 (Mathematics No. 26): Beiträge zur Geometrie der Kreise und Kugeln (20). Von Sôzi Matumura. Pp. 241–256. Vol. 18, No. 12 (Mathematics No. 27): Beiträge zur Geometrie der Kreise und Kugeln (21). Von Sozi Matumura. Pp. 257–274. (Taihoku: Taihoku Imperial University.) [73

Studies from the Connaught Laboratories, University of Toronto. Vol. 9, 1937. Pp. v+50 papers. (Toronto: University of Toronto Press.) [73

Journal of the Indian Institute of Science. Vol. 20A, Part 12: Hydrogenation of Oils by the Continuous Process. Part 1: Hydrogenation of Groundnut Oil by Catalysts of Nickel and its Alloys. By V. T. Athavale and S. K. K. Jatkar. Pp. 95–110. 1.4 rupees. Vol. 20A, Part 13: Activation and Clarifying Properties of Fuller's Earth. Part 2: The Decolourising Action of some Indian Fuller's Earths. By B. S. Kulkarni and S. K. K. Jatkar. Pp. 111–118. 12 annas. Vol. 20A, Part 14: Activation and Clarifying Properties of Fuller's Earth. Part 3: Bleaching of Safflower Oil by Fuller's Earths. By B. S. Kulkarni and S. K. K. Jatkar. Pp. 119–124. 10 annas. (Bangalore: Indian Institute of Science.) [73

Ochrona Przyrody: Organ Państwowej Rady Ochrony Przyrody. Rocznik 17. Pp. vi+361. (Kraków: Państwowa Rada Ochrony Przyrody.) [73

Reports of the Biochemical Research Foundation of the Franklin Institute. Vol. 4, 1936–1937. Pp. iv+25 papers+xxvi. (Philadelphia: Biochemical Research Foundation of the Franklin Institute.) [83

Conseil International des Unions Scientifiques: Union Géodésique et Géophysique Internationale: Association de Séismologie. Publications du Bureau Central Séismologique International. Série A: Travaux Scientifiques. Fasc. No. 15, 2e Partie (Communications présentées a la Conférence d'Édimbourg, Septembre, 1937.) Pp.115–333+1 plate. (Nogent-Le-Rotrou: Imprimerie Daupeley-Gouverneur.) [93

U. S. Department of Agriculture. Technical Bulletin No. 596: Composition and Fractionation of American Steam-Distilled Wood Turpentine. By S. Palkin, T. C. Chadwick and M. B. Matlack. Pp. 30+1 plate. (Washington, D.C.: Government Printing Office.) 5 cents. [93

Kungl. Sjökarteverket, Jordmagnetiska Publikationer Nr. 11: Earth Magnetic Researches along the Coasts of Sweden. Part 2: Dip, Horizontal Force and Vertical Force at the Epoch July 1, 1929. By Gustav S. Ljungdahl. Pp. 49+4 plates. (Stockholm: Statens Reproduktionsanstalt.) [93

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